Finnish Forest Owners' Perceptions about Climate Change Mitigation Strategies in the Forest Sector

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Tiivistelmä – Referat – Abstract

Forests play a key role in climate change mitigation. There are different ways in which forests can contribute to both increasing carbon sequestration and reducing emissions. In Finland, forests are largely owned by private forest owners and thus the actions of these forest owners have a great impact on the climate change mitigation potential of forests. Thereby, this study examined the perceptions of Finnish forest owners on the following climate change mitigation strategies in the forest sector: Forest management, More harvest, Less harvest, Wood products, Conservation, Adaptation, and Land use change. Especially, the study focused on "Less intervention" (a combination of three individual strategies), and "Forest management" as strategies and tested how the following hypothesized aspects are associated with the support for these strategies: the prioritized values affecting the choice between climate change mitigation strategies in the forest sector, risk perception of climate change, political orientation, education level, and the size of forest land. The tested hypotheses were derived from the existing literature on theories and empirical findings on the perceptions of citizens and forest owners. The effect of the independent variables on the chosen climate change mitigation strategies was studied through linear regression analysis based on a quantitative survey with 892 responses. Regression models were established separately for both chosen strategies.

On average, forest owners supported all climate change mitigation strategies in the forest sector, except Less harvest. Further the results of the linear regression analysis supported all hypotheses to some degree. Perceived risk of climate change emerged as an important measure affecting the support for climate change mitigation strategies in general. Left-right political orientation was found important, where individuals positioned more on the right side of the political spectrum generally supported strategies that have more human intervention in forests. Forest owners' prioritized values were discovered to significantly affect the support for climate change mitigation strategies in the forest sector, and forest owners who valued biodiversity gave more support towards Less intervention and less support towards Forest management. Forest owners with a smaller property tended to be slightly more supportive towards Less intervention, but in the Forest management model, the effect was not significant. Similarly, the simultaneous effect of education and political orientation was significant in the Less intervention model, indicating that forest owners with a university degree and right-winged political orientation tended to be more supportive towards strategies with more human intervention in forests, compared to forest owners with a university degree and left-winged political orientation. Apart from hypothesized variables, gender was found a significant predictor of support towards strategies, where, on average, women were more likely to support Less intervention, and similarly be more opposing towards Forest management, compared to men.

In light of the results, Finnish forest owners tend to be rather conscious about climate change and support on average different climate change mitigation strategies in the forest sector. Nevertheless, private forest owners are a heterogeneous group of people whose preferences vary greatly, and thus policies need to be implemented accordingly.

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climate change mitigation, forest management, forest sector, linear regression analysis, political orientation, private forest owners

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Tiivistelmä – Referat – Abstract

Metsillä on tärkeä rooli ilmastonmuutoksen hillinnässä sekä kasvihuonepäästöjen vähennyksen että hiilen sitomisen kannalta. Koska Suomessa metsät ovat suurelta osin yksityishenkilöiden omistuksessa, on heidän toiminnallaan suuri vaikutus metsien ilmastonmuutoksen hillintäpotentiaaliin. Tämän tutkielman tarkoituksena olikin selvittää suomalaisten yksityismetsänomistajien suhtautumista ilmastonmuutoksen hillinnän strategioihin metsäsektorilla. Tutkielma koostui kahdesta tutkimuskysymyksestä. Ensimmäisen tarkoituksena oli selvittää, missä määrin metsänomistajat kannattavat seuraavia strategioita: puuston kasvuvauhdin kiihdyttäminen eri metsänhoitotoimien avulla (esim. lannoitus), hakkuiden kasvattaminen, hakkuiden vähentäminen, pitkäikäisten ja vähäpäästöisten puutuotteiden tuotanto, vanhojen metsien suojelu, tuho- ja tautiriskien minimointi sopeuttamalla metsä muuttuvaan ilmastoon sekä maankäytön muutokset. Toisessa tarkasteltiin eri muuttujien suhdetta kahteen metsiin liittyvään strategiaan: strategiaan, jossa ihmisen toiminta metsissä on vähäistä (vanhojen metsien suojelu ja hakkuiden vähentäminen) sekä metsänhoitostrategiaan, jossa puuston kasvuvauhtia kiihdytetään mm. lannoituksen avulla. Hypoteesit koostuivat seuraavista aihealueista: metsänomistajien priorisoimat arvot vaihtoehtoisten hillintästrategioiden valinnassa, riskikäsitys ilmastonmuutoksesta, poliittinen suuntautuminen, koulutus ja metsämaan koko. Hypoteesit muodostettiin olemassa olevan kirjallisuuden perusteella pohjautuen teorioihin ja empiirisiin havaintoihin kansalaisten ja metsänomistajien käsityksistä. Riippumattomien muuttujien vaikutusta strategioiden kannatukseen tarkasteltiin lineaarisen regressioanalyysin avulla luoden eri mallit molemmille tarkasteltaville strategioille. Aineisto perustui kvantitatiivisen kyselyn 892 vastaukseen.

Tuloksista selvisi, että keskimääräisesti suomalaiset metsänomistajat kannattivat kaikkia muita strategioita paitsi hakkuiden vähentämistä. Lineaarisen regressioanalyysin perustella kaikki hypoteesit saivat tukea tuloksista. Riskikäsitys ilmastonmuutoksesta nousi tärkeäksi tekijäksi vaikuttaen hillintästrategioiden kannatukseen yleisesti. Poliittinen vasemmisto-oikeisto -muuttuja oli myös merkitsevä tekijä: mitä enemmän oikealla, sitä vahvempi kannatus ihmisen aktiivisemmalle toiminnalle metsissä sekä metsänhoitostrategiaan, jossa puiden kasvuvauhtia tehostetaan. Lisäksi metsänomistajien priorisoimat arvot hillintästrategioiden valinnassa olivat merkitseviä: luonnon monimuotoisuutta tärkeimpänä pitävät metsänomistajat kannattivat todennäköisemmin strategiaa, joissa ihmisen rooli metsissä on vähäinen, sekä olivat enemmän vastaan metsänhoitostrategiaa, jossa puiden kasvuvauhtia tehostetaan. Suuremman metsämaan omistajat kannattivat keskimäärin ihmisen aktiivisempaa toimintaa metsissä kuin pienten metsien omistajat. Korkeakoulutetut, poliittisesti enemmän oikealle identifioidut metsänomistajat kannattivat useammin ihmisen aktiivisempaa toimintaa metsissä kuin korkeakoulutetut, enemmän vasemmalle identifioidut metsänomistajat. Hypoteesimuuttujien lisäksi sukupuoli selitti kannatusta molemmissa malleissa: naiset kannattivat miehiä useammin strategiaa, jossa ihmisen toiminta metsissä on vähäistä ja miehiä vähemmän metsänhoitostrategiaa, jossa puuston kasvuvauhtia kiihdytetään.

Suomalaiset metsänomistajat vaikuttavat tulosten perusteella varsin ilmastotietoisilta ja kannattavat yleisesti eri hillintästrategioita. Metsänomistajien piirteet ja mieltymykset vaihtelevat kuitenkin suuresti, mikä on toimintatapoja mietittäessä syytä ottaa huomioon.

Avainsanat – Nyckelord – Keywords

ilmastonmuutoksen hillintä, lineaarinen regressioanalyysi, metsänhoito, metsäsektori, poliittinen suuntaus, yksityiset metsänomistajat

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1 Introduction

1.1 The role of forests in changing climate

Climate change is clearly among the most challenging issues of this century. Drastic reductions of greenhouse gas (GHG) emissions, while simultaneously increasing the carbon sinks, are required in the short term to keep the warming under 2°C above pre-industrial time, or even more desirably reach 1.5°C maximum warming as specified in the Paris Agreement (IPCC, 2018; UNFCC, 2015). According to the Intergovernmental Panel on Climate Change, technically all mitigation pathways aiming to keep the warming to 1.5°C, highly emphasize the role of land use and land use change (IPCC, 2018). In order to achieve the aimed level of warming agreed in the Paris Agreement, all anthropogenic GHG emissions are to be brought down to zero within the following few decades and even below after that (IPCC, 2018; Soimakallio et al., 2016).

Many studies have recognized the key role of forests and wood products in the battle of climate change mitigation (e.g., Häyrinen et al., 2017; Lempriére et al., 2017; Peterson St-Laurent et al., 2018; Van Bodegom et al., 2009). In fact, forests are deemed to have one of the best cost-volume ratio potentials in climate change mitigation (Håbesland et al., 2016). Forests can efficiently contribute to climate change mitigation in two ways: by sequestering and storing carbon to forest biomass and long-lived wood products and by avoiding emissions through substitution (Pingoud et al., 2018). When trees grow, they absorb carbon dioxide from the atmosphere through photosynthesis (Loustau & Rambal, 2010) and store it in wood and eventually in forest soil (Sievänen et al., 2012). In addition to the biological process of the carbon cycle, carbon can be stored in long-lived wood products.

When forests remove more carbon dioxide from the atmosphere than is released back into the atmosphere, they have a cooling effect on the climate and thus act as carbon sinks (IPCC, 2018; Seppälä et al., 2015; Soimakallio et al., 2016). Increasing or preserving the current carbon sinks can be accomplished through land use changes such as afforestation and reforestation or reduced deforestation and degradation (FAO, 2018; IPCC, 2019; Peterson St-Laurent et al., 2018). Reduced deforestation and degradation have the largest immediate climate change mitigation effect, as large amounts of carbon are saved from being released into the atmosphere (Nabuurs et al., 2007). In addition to maintaining or increasing carbon sinks, these actions could positively influence forest ecology (IPCC, 2019).

Carbon sinks and storages can be sustained or improved through various measures that change the carbon density of the forest (FAO, 2018). More intensive forest management techniques include, for instance, cultivated seeding and the use of fertilizer as ways to increase the growth rate of forests (Ilvesniemi, 2012), as well as increased harvest to ensure the production of longer-lived and lower-emission wood products (Peterson St-Laurent et al., 2018). Adaptive measures for avoiding diseases and damages, such as species selection, are closely related to forest management strategies (Nabuurs et al., 2007). These more intensive forest management strategies contradict the benefits from less intensive forest management such as decreased harvests and old forest conservation (Peterson St-Laurent et al., 2018). According to Luyssaert et al. (2008), old forests store massive amounts of carbon and besides could amass it for hundreds of years. Stemming from this, old forests would become a massive source of carbon if felled, hence giving grounds for supporting the conservation of the old forests. Even so, compared to younger forests, old forests at the end of their life span are considered to have a lower capacity to sequestrate carbon, especially in the boreal forests (IPCC, 2019). Thus, they may transform into a small sink or even a source over time (ibid.).

Substitution, i.e., the use of wood-based materials and fuels in place of more emission-intensive alternatives, can be used to reduce emissions (FAO, 2018; IPCC, 2019; Peterson St-Laurent et al., 2018). Nevertheless, Soimakallio et al. (2016) point out the great variation in the substitution effect between products, which in turn creates uncertainties for this mitigation strategy. In analyzing the substitution effect of a certain product, the whole existence of the product, from extraction to final stages of the lifecycle, has to be considered (Lempriére et al., 2013). Even though minimizing the GHG emissions is often seen as the most beneficial mitigation strategy in the short-run (ibid.), increased harvests could be justified if they were to substitute for fossil-based materials and hence could bring climate benefits in the long term (Seppälä et al., 2015).

Concerning climate change, the role of forests has been incrementally regarded in political decision-making (Romppanen, 2020). The European Union (EU) climate policy was executed to direct climate change mitigation and adaptation actions on the EU level and nationally in each member state (Ministry of the Environment, n.d.). The EU incorporated land use, land use change, and forestry (LULUCF) Regulation (2018/841) in the EU climate policy, which entered into force in 2021. The Regulation accompanies the EU emission trading system and establishes new rules for recording emissions and removals in the LULUCF sector (Romppanen, 2020). The regulation contains a no debit rule, which states that the emissions from the LULUCF sector cannot surpass the removals from

2021 to 2025 and from 2026 to 2030 in each member state (Ministry of Agriculture and Forestry, n.d). Henceforth, the emissions from land use are entailed in the national emission reduction targets (Ministry of Agriculture and Forestry, 2019). The international and EU level policies are highly linked to local strategies in member countries. As agreed in the current Climate Change Act, Finland is entailed to decrease its GHG emissions by at least 80% by 2050, compared to emissions in 1990 (Ministry of the Environment, 2020). This complies with the target of the EU of being carbon neutral by 2050 and is part of Finland's path on the aim to reach carbon neutrality already by 2035 (Ministry of the Environment, 2020). Furthermore, the National Forest Strategy executes the sustainable development aims of Agenda 2030 (set by UNFCCC) related to forests with the main goal of increasing sustainable management and use of forests (Ministry of Agriculture and Forestry, 2019).

However, to successfully implement climate change mitigation strategies, the understanding and acceptance of the citizens on the importance of climate change mitigation are also needed (Peterson St-Laurent et al., 2018). According to the literature, the attitudes and actions on climate change are highly affected by an individual's risk perception, that is, how much one worries about the hazard, and comprehends the impacts and causes of it (Brody et al., 2008). Moreover, values play a key role in defining objectives (Peterson St-Laurent et al., 2018), thus affecting how climate change mitigation is perceived. Also, various socio-demographic characteristics have been found to influence how climate change is viewed. For instance, conservatism or right-winged orientation have been discovered to be an indicator of greater climate change skepticism, especially in the US (e.g., Akerlof et al., 2013; McCright & Dunlap, 2011) but also internationally (e.g., McCright et al., 2015; Unsworth & Fielding, 2014; Ziegler, 2017). This effect of political orientation on climate change views has been barely researched in Finland, especially from the point of view of climate change mitigation. Despite climate change recognition varies greatly between individuals, in Finland citizens generally seem to acknowledge that climate change is occurring, and the majority believes the cause to be mostly anthropogenic (Ministry of the Environment, 2019). Furthermore, climate change mitigation is considered necessary (Wallius & Terävä, 2020).

1.2 Forest ownership in Finland

In Finland, forests cover around 75% (22.8 mil. ha) of the total land area (Lier et al., 2019), making Finland proportionally the most forested country in Europe (Palo & Lehto, 2012). It has been estimated that in Finland, forests have steadily grown from the beginning of the twentieth century onwards (Seppälä et al., 2015), whilst as carbon sinks, these forests have acted consecutively for decennials (Soimakallio et al., 2016). Currently, without accounting for land use emissions, forest carbon sinks in Finland cover around half of the annual national emissions (Lier et al., 2019). In addition to acting as carbon sinks, forests are subject to various environmental, economic, and social aspects. The importance of the forest industry for the national economy of Finland is prominent, accounting for around 20% of all exports (Finnish Forest Industries, 2020). At the same time, forests are important for sustaining biodiversity, for which the intensive commercial use of forests is destructive (Harlio, 2017).

In Finland, non-industrial private forest (NIPF) owners own the majority (60%) of the forestry land, and these lands account for around 80% of domestic commercial cuttings (Karppinen et al., 2020). Given the size of the NIPF owner group, their role in sustainable forest management cannot be emphasized enough. Following this, Takala et al. (2019) stress the eventual power of private forest owners: albeit forest industry and experts impact the practices in the forest sector significantly, after all, the decision on how the forest land is managed, falls on the forest owner. The renewal of the Forest Act (1093/1996) in 2014 brought along increased freedom for forest owners concerning the management of their land (Häyrinen, 2019; Karppinen et al., 2020; Takala et al., 2019).

In the context of forest management, several studies have shown the vast variety of private forest owners' interests and motives (Ficko et al., 2019; Håbesland et al., 2016; Häyrinen et al., 2017; Juutinen et al., 2020; Karppinen et al., 2020). In addition to the financial benefits from wood, non-material values of forests such as recreation and carbon sequestration have also triggered interest (Ficko et al., 2019). Forest owners are increasingly putting weight on these management strategies focusing on goals other than timber supply (Hynynen et al., 2015; Häyrinen et al., 2015). The proportion of these forest owners is further expected to rise, as NIPF owners are increasingly living in cities, are more educated, and have other sources of income than mere forestry (Häyrinen et al., 2015; Karppinen et al., 2020). Compared to their predecessors, the future forest owners might not have similar knowledge of accustomed forest management practices, and thus might not be interested in implementing these traditional practices focused on timber supply (Häyrinen et al., 2015). Besides, their degree of involvement may vary greatly from active management to more passive (Khanal et al., 2017). This change in the ownership structure of forests has been regarded as a possible threat for the forest industry (Follo et al., 2017), while from the other perspective, it can be seen as an asset when various forest ownership objectives are supported (Weiss et al., 2019). However, as Pynnönen

(2020) notes, currently there is a lack of services directed to forest owners valuing objectives other than wood production, which could partly deflate the interest of more intangible forest uses.

Forest owners are the group for which the execution of the climate change mitigation potential of forests largely falls. Therefore, as forest owners' views and beliefs about climate change highly dictate the support or opposition for climate change mitigation (Khanal et al., 2017), it is a crucial area of study that has not yet been covered in Finland. Also presumably, forest owners have different preferences for their own forest land than what the general public considers the most suitable in terms of climate change mitigation in the forest sector. Even though the research regarding management actions and preferences of forest owners, as well as the factors affecting the choice of different management practices, is quite extensive, most of the studies approach the phenomenon at a more general level, not focusing on climate change mitigation strategies specifically.

1.3 The aim of the study

While acknowledging the central role of forests in climate change mitigation, the mitigation potential is highly dependent on the owners of the forest estates. In Finland, the ownership is mainly under the NIPF owners, who are a heterogeneous group of people in their characteristics, objectives, and decisions concerning forests. Therefore, to design policies accordingly, it is crucial to study their motivations and perceptions towards climate change mitigation in the forest sector, not forgetting the perceptions towards climate change in general. Earlier research examining private forest owners' stances towards climate change and climate change mitigation in the forest sector is minor, particularly in the context of Finland. Thereby, this thesis aims to contribute to filling this gap by answering the following research questions:

1) Which climate change mitigation strategies do the Finnish forest owners support?
2) Which factors are associated with the support or opposition for different climate change mitigation strategies in the forest sector?

This thesis will answer these questions by a statistical analysis of an original set of survey data, collected in spring 2020, on Finnish forest owners' perceptions about climate change and various climate change mitigation strategies in the forest sector. While aiming at mitigating climate change, the strategies differ in terms of the intensity of human intervention in forests. This study focuses on the following strategies with less human intervention in forests: decreasing harvests and conserving old forests, and with more human intervention in forests: increasing harvests, applying forest management measures that increase carbon sequestration, producing longer-lived and lower-emission wood products, minimizing diseases and damages through adaptation, and changing land use.

A literature review on the existing data about citizens' perceptions towards climate change, forest owner perceptions towards forest management strategies in general, along with information about climate change mitigation strategies, supports the data analysis by providing the bases for testing the hypotheses. The tested hypotheses are the following: the prioritized values, the risk perception of climate change, political orientation, the level of education, and the size of the forest holding, affecting the level of support for different climate change mitigation strategies in the forest sector. This thesis follows the structure of Peterson St-Laurent et al. (2018) study, with the main distinction that the focus of the thesis is on forest owners in Finland, by comparison to Peterson St-Laurent et al. who studied the perceptions of the general public in Canada.

The structure of the thesis is as follows. In chapter 2, the hypotheses are developed based on existing literature. Continuing from the theoretical background of the thesis, the research design and sample are introduced in chapter 3. In chapter 4 the methods of the study, that is, the use of analyses is introduced. Following the methods, chapter 5 proceeds to the hypothesis testing i.e., presents the results of the analyses and answers the research questions. In chapter 6 the results are construed together with the consideration of reliability, validity, and limitations of the thesis as well as suggested further research. Finally, chapter 7 concludes the entire study and the findings.

2 Hypothesis development

2.1 Prioritized values

According to goal-setting theory (further presented in the next section 2.2), personal values are seen as a pivotal aspect in defining personal objectives and in attaining them (Locke & Latham, 1991). Also, Peterson St-Laurent et al. (2018) view values and beliefs as explanatory factors behind objectives. Gregory et al. (2012) specify objectives to be the directional element behind a choice, namely because objectives are something that is preferred by an individual. Hence, values, and further objectives are important factors when interpreting the perceptions of forest owners towards various climate change mitigation strategies. They show what is truly important for forest owners and what strategies are favored. Naturally people, or here forest owners, have different preferences and values regarding the management and utilization of resources (Loring & Hinzman, 2018). Motivations behind individual perceptions could for example vary between financial and nonfinancial values (Loring & Hinzman, 2018) and between individual and collective values towards resource management (Kahan et al., 2012; Loring & Hinzman, 2018).

Even though timber production is clearly the main focus in the forest sector in Finland, other forest management objectives are increasingly emphasized (Häyrinen et al., 2017). Peterson St-Laurent et al. (2018, p.4) describe how values concerning forest management are often placed on a scale from “biocentric” to “anthropocentric”. Nonetheless, various terms have been used to describe people’s orientation towards forests. Concerning people’s perceptions about environmental management, Li et al. (2010, p.2243) recognize two types of environmental value orientations: “utilitarian” and “ecology”. The former refers to a vision where the role of forests is to mainly offer benefits for humans (ibid.). As a contrast, the latter orientation refers to a more nature-centered viewing, where environmental protection and upkeep of ecosystems are prioritized (ibid.). These prescribed terms seem to have equivalent ideologies as the terms used by Peterson St-Laurent et al. (2018), utilitarian referring to anthropocentric orientation and ecology referring to biocentric orientation.

Peterson St-Laurent et al. (2018) emphasize that concerning the role of forests in climate change mitigation, these former polarized orientations might be challenging. Despite biocentric individuals who would often support actions that minimize the effect of humans on nature, in the concept of climate change mitigation, they may encourage active forest management if it is less harmful to ecosystems in the long run than inactivity (ibid.). Based on the impact of values on human actions the following hypothesis is to be tested:

H1. Forest owners who prioritize the economic values of forests are more likely to support strategies that have more human intervention in forests.

2.2 Risk perception

In the context of climate policies, citizens' support or opposition is in many respects an outcome of their risk perception (Leiserowitz, 2007). Risk perception is found to change based on personal and historical experiences (Crona et al., 2013; Spence et al., 2011). If one has experienced an incident recently or the risk can be easily pictured, risk perception is seen to be higher (Spence et al., 2011). Spence et al. (2011) introduce an idea of goal-setting theory in the context of climate change. In line with the theory, people might be more confident in feeling that their actions can lead to better results if they can clearly associate themselves with the prospective climate change effects (ibid.). Since the visible changes of climate change are a result over a long time span, it might be difficult for an individual to recognize and experience climate change impacts per se (Spence et al., 2011; van der Linden, 2015). Thus, seasonal changes and weather events might be the first signs for an individual to assess climate change (Spence et al., 2011). The more individuals are able to feel the changes of climate change personally, the better they usually comprehend the risks of climate change (Akerlof et al., 2013).

Furthermore, risk perception can be measured through the concept of worry, sometimes incorrectly referred to as "concern, perceived seriousness, or perceived risk" as expressed by Gregersen et al. (2020). Also van der Linden (2015) claims these to be different terms since it is possible that one has concern over climate change but is not personally worried about it. Indeed, as van der Linden (2015) further suggests it is good to make a distinction between personal and public levels of risk perceptions. People often regard climate change as a greater risk societally rather than personally (Leiserowitz, 2007). How well individuals realize the seriousness and the consequences of climate change could affect their future decisions and support for climate change mitigation policies (Brody et al., 2008). Furthermore, research has shown that individuals who believe in the human-cause of climate change are more worried about climate change and often more willing to act on behalf of it (Gregersen et al., 2020). Based on the theory and earlier studies about risk perception the following hypothesis is to be tested:

H2. Forest owners who worry about climate change and are more concerned about the impacts of climate change are more likely to support climate change mitigation strategies.

2.3 Political ideology

Political ideology is seen to comprise a combination of beliefs and values that could help in explaining the reasons behind human actions and choices (Hu et al., 2017). It is also comprehended to be a highly powerful factor in explaining climate change views (e.g., Akerlof et al., 2013; McCright & Dunlap, 2011; Unsworth & Fielding, 2014). According to previous research, those who consider themselves to be more on the left in the political spectrum or liberal are more likely to consider climate change as human-caused (Gregersen et al., 2020) and associate climate change as more threatening (Gregeresen et al., 2020; Hu et al., 2017; McCright et al., 2015; Newman et al., 2020) than their right-leaning or more conservative counterparts. In the US for instance, where climate change is greatly a politicized matter, the differences between right and left are even clearer (Czarnek et al., 2021; Newman et al., 2020). However, Czarnek et al. (2021) and Newman et al. (2020) emphasize the variation between countries regarding the effect of political orientation on climate change views, and Czarnek et al. (2021) state that US-based studies, which are a majority in the subject, should not be applied to other countries as such. Parallel to the US, in the EU, policymakers as well as the general public are much less visible in climate change disavowal (McCright et al., 2015). Ziegler (2017) further points out that especially in Europe these different political dimensions might not be disconnected from each other. He provides Germany as an example where conservative orientation often goes hand in hand with liberal orientation.

According to Jost et al. (2003), the main differences between conservative and liberal ideologies lie in the aspects of how change is approached and how equality is valued. Conservatives oppose change and disorder and emphasize individualistic values (ibid.). As a contrast, liberals are willing to adopt change and often value equality over individualism (ibid.). The left-right dimension contains largely the same division of equality valuation. Left-winged individuals support equality and are thus more likely to carry responsibility for the planet and the people affected by climate change even if the impacts would not affect their lives personally as such (Gregersen et al., 2020). As McCright and

Dunlap (2011) express, environmental protection hampers the traditional conservative objectives of decreased governmental interference and private ownership, which could explain less support for environmentally friendly actions from individuals identifying themselves as conservative. Climate change is seen to affect conservative values, such as economic growth, much more than liberal values (McCright & Dunlap, 2011). Hu et al. (2017) further point out how climate change forces change and shakes the traditional functioning of systems, i.e., challenges the core values of conservative ideology. Due to these unfavorable effects of climate change, conservatives could be opposing even towards the existence of such crisis, especially in the US, where climate change is highly politized (McCright & Dunlap, 2011).

Traditionally, the left-right dimension has been used in politics to identify the ideologies of voters and parties. Even though this spectrum has been widely used in views concerning socioeconomic matters such as taxation, in many western democracies its role has consisted of a larger set of matters than merely economic (Isotalo et al., 2020). However, according to Isotalo et al. (2020) in Finland the right-left spectrum is still mainly applicable to economic values. Another dimension, which illustrates identities and lifestyles that have been discussed and acknowledged more in the recent decades, is called the GAL-TAN dimension (Green-Alternative-Libertarian vs. Traditional-Authoritarian-Nationalist) (ibid.). GAL-TAN dimension has for example corresponded to green values and the position of minors. In the study by Isotalo et al. (2020), GAL-TAN values are divided on a spectrum from 0 to 10. Values smaller than 4 represent the GAL side of the spectrum, values from 4 to 6 the middle, and values over 6 the TAN side. In Finland, the support towards GAL values has increased amongst voters since the 2011 parliamentary elections (ibid.). Based on the average position of party voters on the GAL-TAN spectrum, in the 2019 parliamentary elections, the most green-liberal parties, located in the GAL side of the spectrum, were the Greens and the Left Alliance. In the middle, but more towards the GAL side were located the Swedish Peoples' Party of Finland, the National Coalition Party, and the Social Democratic Party of Finland (SDP). Also, the Centre Party was situated slightly towards the GAL side of the spectrum. In the middle but more on the TAN side of the spectrum sat Christian Democrats, while the Finns Party was the most national-conservative party, located in the TAN side of the spectrum (Isotalo et al., 2020).

In Finland and many other western democracies, ideological differences between parties have traditionally been small. However, polarization has been a strengthening trend in recent years (Isotalo et al., 2020). This can be noticed as more differing stands in elections and more troublesome cooperation between parties (ibid.). Yet, in Finland, all main parties (here considered the parties with over four seats in the parliament i.e., the parties mentioned above) acknowledge climate change and have a climate programme. However, the degree of measures and goals varies considerably from party to party. Disparities can be measured with different topics in the climate change context, some of the main ones being the objectives of becoming carbon neutral and the degree to which Finland should reduce its emissions (Elonen & Mikkonen, 2019). The majority of the parties do not have sufficiently ambitious goals that would support the aim of 1.5°C warming. The parties whose climate alignment is close to this aim are the Greens and the Left Alliance (Elonen & Mikkonen, 2019). From the perspective of climate change mitigation, the Finns Party appears to be the most unsupportive as they are often holding back pro-environmental actions (ibid.).

In the context of climate change and forests, carbon sinks are one of the major factors dividing parties. The Greens' stance on massive harvests is the most opposing as they seek for decreased harvests and sustainable use of forests to safeguard biodiversity and forest carbon sinks (*Metsäpoliittinen ohjelma*[1], 2020). The Left Alliance has a less radical stance towards harvests as for them it is adequate to keep harvests at a level that will strengthen the forest carbon sinks and protect biodiversity (*Vasemmistoliiton ilmasto-ohjelma*[2], 2018). SDP has ambitious outlooks for carbon sinks as they would increase them already by 2030 (*SDP:n ilmasto-ohjelma*[3], 2019). However, in order to increase sinks by 2030, harvests should be decreased, yet SDP is not explicitly against increased harvests (Hartikainen, 2019). Christian Democrats give a reason for increased harvests through the substitution impact of wood. However, they emphasize the role of forest owners in carbon sink management and would entrust the decision of harvests for them (*Kristillisdemokraattien ilmasto- ja energiaohjelma*[4], 2019). The Centre Party values the role of forestry while still emphasizing the sustainable use of forests (*Keskustan metsälinjaus*[5], 2019). They see the utilization of forests and increased harvests as an important part on the way to a fossil-free economy (Pohjola, 2019). The National Coalition Party finds the long-term role of forests as carbon sinks important, yet they do not want to increase sinks at the forest owners' expense (*Kokoomuksen ympäristöohjelma*[6], 2019). Hence, they are not against increased harvests (Hartikainen, 2019). According to the Finns Party, forestry is at a sustainable level

[1] The Forest Policy Programme of the Greens
[2] The Climate Programme of the Left Alliance
[3] The Climate Programme of the Social Democratic Party of Finland
[4] The Climate and Energy Programme of the Christian Democrats
[5] The Forest Alignment of the Centre Party
[6] The Environmental Programme of the National Coalition Party

in Finland (*Perussuomalainen ympäristö- ja energiapolitiikka*[7], 2019) and they do not oppose increased harvests (Hartikainen, 2019). The Swedish Peoples' Party takes the same stance as they approve increased harvests (Koivisto, 2019). In summary, parties that sit more on the right in the political spectrum, are more supporting – or at least more approving towards increased harvests.

Based on the earlier studies on the effect of political ideology on perceptions and beliefs, and accounting for the Finnish political environment, the following hypotheses are to be tested:

H3A. Finnish forest owners identifying themselves as more green-liberal (i.e., the Greens and the Left Alliance) than national-conservatives are more likely to support strategies that have less human intervention in forests.

H3B. Finnish forest owners who consider themselves to be more on the right in the political spectrum, are more likely to support strategies that have more human intervention in forests.

2.4 Joint effect of political ideology and education

Various studies in Finland have found a nexus between the level of education of forest owners and the degree of support for forest conservation – the ones who are more educated, are more likely to support conservation actions (e.g., Hallikainen et al., 2010; Häyrinen et al., 2015). Furthermore, some studies have found political ideology to influence the linkage between education and the perceptions of climate change. For liberals or left-winged, higher-level education has been discovered to positively affect the views on climate change, whereas for conservatives or right-winged the relationship has been weaker or even negative (Czarnek et al., 2021; McCright & Dunlap, 2011). To explore this linkage the following hypothesis is to be tested:

H.4. The effect of education on the support for strategies with less human intervention in forests is positive for green-liberals or left-leaning individuals but weaker or negative for conservative-nationalists or right-leaning individuals.

[7]The Environment and Energy Policy of the Finns Party

2.5 The size of forest land

Forest ownership in Finland is undergoing a transformation where forest land is scattered into smaller properties, while simultaneously the number of very large properties is increasing (Karppinen et al., 2020). The scattering of forest land has caused the average size of a forest land per owner to decrease. As the smaller forest land indicates less economic value, these small-scale forest owners might be less eager to participate in active forest management (Suuriniemi et al., 2012). Accordingly, as small-scale forest owners do not have to rely on the earnings from forestry, they have often other preferences for owning forests not related to timber supply (ibid.). Contrary, their larger forest-owning counterparts often value timber supply as they are more dependent on the income from forestry (Aguilar et al., 2014). In line with a Swedish study by Eggers et al. (2014), the size of the forest land is considered to be a significant factor in the decision for different forest management strategies. Somewhat similarly, Lidestav & Ekström (2000) conclude that a larger property size can be associated with increased harvests. Deriving from the earlier studies the following hypothesis is to be tested:

H5: Forest owners with a larger forest land are more likely to support strategies that have more human intervention in forests (e.g., increased harvests).

2.6 Summary of expected effects of hypothesized variables

Table 1 compiles the predictable effects of hypothesized variables on the dependent variables, i.e., on the support or opposition for the climate change mitigation strategies in the forest sector. These have been divided into strategies that require less human intervention (i.e., conservation of old forests and reduced harvests) and strategies that require more human intervention (i.e., all other strategies).

Table 1. Expected effects of hypothesized factors on the support for climate change mitigation strategies in the forest sector. The "+" sign implies a positive relationship, whereas the "-" sign a negative relationship. The "+/-" sign indicates no explicit hypothesis.

Factors	**Climate change mitigation strategy**	
	Strategies with less human intervention	Strategies with more human intervention
H1 Prioritized values		
a) Environmental values	+	+/-
b) Economic values	-	+
H2 Risk perception		
1) Belief in human-cause of climate change	+	+
2) Worry about climate change	+	+
3) Concerns about the impacts of climate change	+	+
H3 Political ideology		
1) GAL-TAN		
a) GAL	+	-
b) TAN	-	+/-
2) Left-Right		
a) Left	+	-
b) Right	+/-	+
H4 Education x political ideology (combined effect)		
1) High education x left wing/GAL	++	--
2) High education x right wing/TAN	+/-	+/-
H5 Size of the forest land		
a) Small	+	+/-
b) Large	+/-	+

3 Material

3.1 Survey

3.1.1 Data collection

The quantitative research method was used to obtain more data and to be able to describe the researched phenomenon in general and more reliably (Metsämuuronen, 2011). The data utilized in this study was collected with a questionnaire implemented in Finnish in the spring of 2020. Email was used to distribute the questionnaire to a sample of forest owners living in selected regions in Finland: Uusimaa, Päijät-Häme, and North Karelia. North Karelia and Päijät-Häme were selected based on the importance of silviculture in these regions while Uusimaa served as a control group. The email addresses of the forest owners were received from the Finnish Forest Centre (FFC) which is a state-funded organization operating under the Ministry of Agriculture and Forestry. The questionnaire was sent to all these obtained email addresses, i.e., to 18 000 individuals. After the responses were collected, the email addresses received from the FFC were destroyed according to the agreement between FFC and the University of Helsinki and in line with the European Union General Data Protection Regulation guidelines.

In total, 2182 responses were received. However, three responses occurred twice in the data set, leading to an actual number of 2179 respondents. This corresponds to a response rate of 12.1%. Nonetheless, a considerable number of the email addresses were out-of-date, meaning that the questionnaire did not reach the whole intended sample, thus increasing the actual response rate. The number of the obtained email addresses varied between regions, influencing the number of responses received from these regions. The sub-sample of Uusimaa had the largest amount of responses (1271), followed by North Karelia (539), and Päijät-Häme (369). The sub-sample of Uusimaa had the highest response rate of 22%, followed by Päijät-Häme (12%) and North Karelia (11%).

3.1.2 Questionnaire design to test the hypotheses

The questionnaire was designed to assess the levels of support for different climate change mitigation strategies in the forest sector, to unravel the perceptions of climate change amongst the Finnish forest owners, and to evaluate their preferences on various carbon offset schemes. Questions in the survey provided measures for testing the hypotheses, that were used in statistical analyses as dependent and independent variables. The questionnaire consisted of four parts based on the objectives of the survey. The first part focused on background information. These questions included age, gender, level of education (to be used to test H4), occupation, political orientation (H3 and H4), and the size of the owned forest land in hectares (H5).

In the second part, questions measured beliefs and attitudes concerning climate change, to evaluate the risk perceptions related to climate change (H2) on a five-point ordinal scale. On the scale, 1 referred, depending on the question, to either “not at all worried”, “never” or “not at all” and, equivalently, 5 referred to “very worried”, “daily”, “a lot”. These Likert-type questions included worry about climate change, the frequency of thinking about the possible consequences of climate change, and the expected impacts of climate change on various aspects from an individual level to a global level. Belief in the cause of climate change (H2) was measured through a categorical variable with options 1) human actions, 2) natural processes, 3) both human actions and natural processes equally, and 4) do not know. Additionally, a fifth option was provided for respondents who did not believe in climate change at all.

The third part mapped out perceptions about climate change mitigation. With a Likert-type question similar to measuring risk perception (mentioned above) the respondents were asked to specify how important they consider climate change mitigation 1) within all sectors, and 2) in the forest sector specifically. This question was asked to collect insights into how forest owners see the effects of the forest sector relative to other sectors and to discover how willing they are to act given their level of worry (identified in the previous part of the survey). Further, the part examined the values affecting the choice between the alternative climate change mitigation strategies in the forest sector (H1) with a ranking scale question where respondents were asked to rank factors from 1= “most important” to 5= “least important”. Ranked factors were: 1) costs, 2) mitigation effectiveness, 3) effects on biodiversity, 4) effectiveness on minimizing the risk of diseases and damages, and 5) effects on the local economy.

The third part also discovered perceptions on forest-based strategies that mitigate climate change. Seven possible climate change mitigation strategies in the Finnish forest sector and their effects were shortly explained in the questionnaire (Table 2) and the respondents were asked to express their level of support or opposition towards them, using a five-point ordinal scale where 1= “strongly resist” and correspondingly 5= “strongly support”. These strategies formed the base for dependent variables in the linear regression analysis, however, they were to some degree modified through factor analysis (see section 4.1 for details and section 5.2 for the results of the factor analysis) before testing the hypotheses.

Table 2. Climate change mitigation strategies studied in the survey.

1. Forest management: forest management actions that increase the growth rate of trees (e.g., the use of cultivated seeds or fertilizer).
2. More harvest: increased harvests to replace more emission-intensive products with wood products. Could bring mitigation benefits in the long run.
3. Less harvest: decreased harvests to increase and maintain current sinks. Could have mitigation benefits in the short run.
4. Wood products: production of longer-lived and lower-emission wood products to store carbon for a longer time and substitute for more emission-intensive products.
5. Conservation: conservation of old forests to protect large carbon storages from being released to the atmosphere, and to take care of biodiversity.
6. Adaptation: minimizing the risk of diseases and damages by adapting the forest to changing climate (e.g., through alterations in species portfolio and avoidance of wind and snow damages).
7. Land use change: reforestation of wastelands to increase sinks and avoided deforestation to decrease carbon released into the atmosphere.

The final, fourth part dealt with alternative carbon offset schemes, that are not focused on in this thesis. In addition, the questionnaire incorporated an open-ended question in the end to allow the respondents for feedback or comments. A detailed description of all questions used in this thesis can be found in Appendix 1.

3.2 Data

3.2.1 Preliminary data modification

Out of 2179 received responses (see 3.1.1), the incomplete or falsely answered questions were coded as “not available” (NA) and subsequently excluded from the analysis. After the elimination, 1506 complete responses remained. Most of the NAs emerged from the ranking scale question (question 13) where the respondents were asked to rank values affecting their choice between the alternative climate change mitigation strategies in the forest sector. Since political orientation was an important factor in the hypothesis testing (H3 and H4), all responses not providing information, i.e., “Prefer not to answer” or “Other”, were coded as “not applicable” (NA) and excluded from further analysis. In line, the “Prefer not to answer” responses in the education variable (H4) were coded as NA. After this recoding, 892 responses remained that were usable in all further analyses. Additionally, all numerical variables were standardized (mean=0, SD=1). For simplicity, treatment coding (i.e., dummy coding) was implemented for all categorical variables as it was best suited for interpretation of hypotheses H1 (values affecting the choice between the alternative climate change mitigation strategies in the forest sector) and H2 (belief in the human cause of climate change). In treatment coding, each level of a variable is compared to the chosen reference level.

3.2.2 Data description – background variables

Descriptive statistics were calculated for all variables based on the 892 usable responses. Table 3 shows the forest owner and forest land-specific characteristics of the data by region and in total and compares it to the *Finnish Forest Owner 2020 (FO2020)* study by Karppinen et al. (2020). The respondents in this study were slightly younger, clearly more educated, more often wage earners than pensioners, and on average owned a larger forest property. Even though education was not fully comparable to the *FO2020* study due to slightly different categories, the proportion of forest owners with a higher education degree was still considerably higher (>80% vs. <50%). The distribution of gender was similar in both studies. Regional differences were found within education, as Uusimaa had notably higher-educated respondents.

Even though a similar distribution of gender was found in the *FO2020*, the percentage of women amongst all Finnish forest owners has been estimated to be around 40% (Karppinen et al., 2020). However, when forest land is owned together with a spouse, usually the man is the one responsible for the management of the forest (ibid.). This could justify the gap in the gender distribution of respondents and explain why men have in general been more active in responding to the survey.

Support for political parties was not studied in the *FO2020*, thus not allowing the comparison to Finnish forest owners in general. Regarding the political orientation, the regional differences in sub-samples were salient. Centre Party was the most supported party in North Karelia (59%) among the respondents of this study whereas in Uusimaa it received only 16% of the votes. In Uusimaa, the National Coalition Party was supported by the majority of the respondents (53%) and was also the overall most supported party in the data. The party distribution was compared to the results of the 2019 parliamentary elections (Official statistics of Finland, 2019) and the full comparison can be found in Appendix 2. Similar to our study, the National Coalition Party received the most votes (21%) in the Uusimaa region. In North Karelia, the Centre Party received the biggest share of votes (24%). In Päijät-Häme, the Social Democratic Party received the most votes (23%), compared to 7% in our study. The National Coalition Party, which was placed third in real elections in Päijät-Häme, received the most votes in the region in our study.

Table 3. Descriptive statistics of the data by regions (usable responses), all usable responses, and total responses compared to the *Finnish Forest owner 2020* study.

Descriptive statistics	Uusimaa (n= 552)	P-Häme (n= 148)	N Karelia (n= 192)	Usable (n=892)	Total (n=2179)	FO2020 (n=6542)
Gender (%)						
Male	71	76	80	74	73	75
Female	28	24	20	26	26	25
Prefer not to say	1	0	1	0 (n=4)	1 (n=17)	-
Age (%)						
< 45	17	23	24	20	15	12
45-54	19	20	19	19	16	14
55-64	29	33	31	30	24	23
65-74	27	22	23	25	22	33
> 74	8	2	3	6	5	17
NA	-	-	-	-	18 (n=385)	-
Average Age	58	55	55	57	57	62
Education (%)						
Elementary school	0	1	5	1	3	28*
High school or voc.	6	19	29	13	16	27
Univ of applied sciences	19	40	32	25	27	27
University	74	40	34	60	53	18
Prefer not to say	-	-	-	-	1	-
Occupation (%)						
Agricultural entrepreneur	1	17	13	6	5	9
Other entrepreneur	13	10	13	12	11	6
Wage earner	46	46	37	44	40	37
Pensioner	36	26	34	34	39	47
Other	5	1	4	4	5	2
Party (%)						
Centre Party	16	30	59	28	17	**
Christian Democrats	2	3	1	2	1	**
Finns Party	5	9	15	8	6	**
Greens	13	8	6	11	6	**
Left Alliance	3	1	2	2	1	**
National Coalition Party	53	41	14	42	23	**
Social Democratic Party	7	7	3	6	4	**
Swedish Peoples' Party	2	0	0	1	1	**
Other	-	-	-	-	5	**
Prefer not to say	-	-	-	-	36	**
Size of forest land (%)						
1-9,9 ha	7	6	3	6	6	16 ***
10-19,9 ha	19	14	9	16	16	23
20-49,9 ha	32	33	28	31	32	33
50-99,9 ha	22	22	32	24	24	17
> 100 ha	21	25	28	23	20	12
NA	-	-	-	-	2 (n=36)	-
Av. size of forest land, ha	77	77	91	80	75	48

*In the *FO2020* categories for education were: "No vocational education" (here refers to "Elementary school"), "Vocational school" (here includes also "High school"), University of Applied Sciences/ College", and "University".

**Respondents' partisanship was not studied in the *FO2020*.

***The *FO2020* study does not contain forest acreages below 5 ha.

Land size and sociodemographic variables, other than education and political orientation, were used as such in further analysis. Age and land size were continuous variables, whereas the rest were categorical.

3.2.3 Data description – variables concerning climate change

The responses regarding the perceptions of climate change were further modified (see next section 3.2.4) before testing the hypotheses. Thus, the distributions of the responses on these variables are presented here, as they are considered to describe the data rather than show the actual results of the study. First, the majority (63%) of the respondents believed in the human cause of climate change, while a third (31%) believed that climate change is equally caused by anthropogenic and natural processes. Only 6% of the respondents either believed that climate change is fully natural, thought it is not true, or stated that they do not know the cause.

On average, the respondents were worried about climate change and the various future impacts of climate change, and they considered climate change mitigation important across sectors (Figure 1). Climate change was seen to affect the world population the most, whereas least of the respondents thought the effect would be that disastrous for oneself. Climate thinking, measuring the frequency at which respondents think about the possible consequences of climate change, obtained the lowest mean score of these measured variables. The distribution of responses for variables measuring the overall worry about climate change (climate worry), the frequency at which the consequences of climate change are thought of (climate thinking), the believed impacts of climate change (climate impact), and the perceived importance of climate change mitigation (climate action) can be seen in Figure 1.

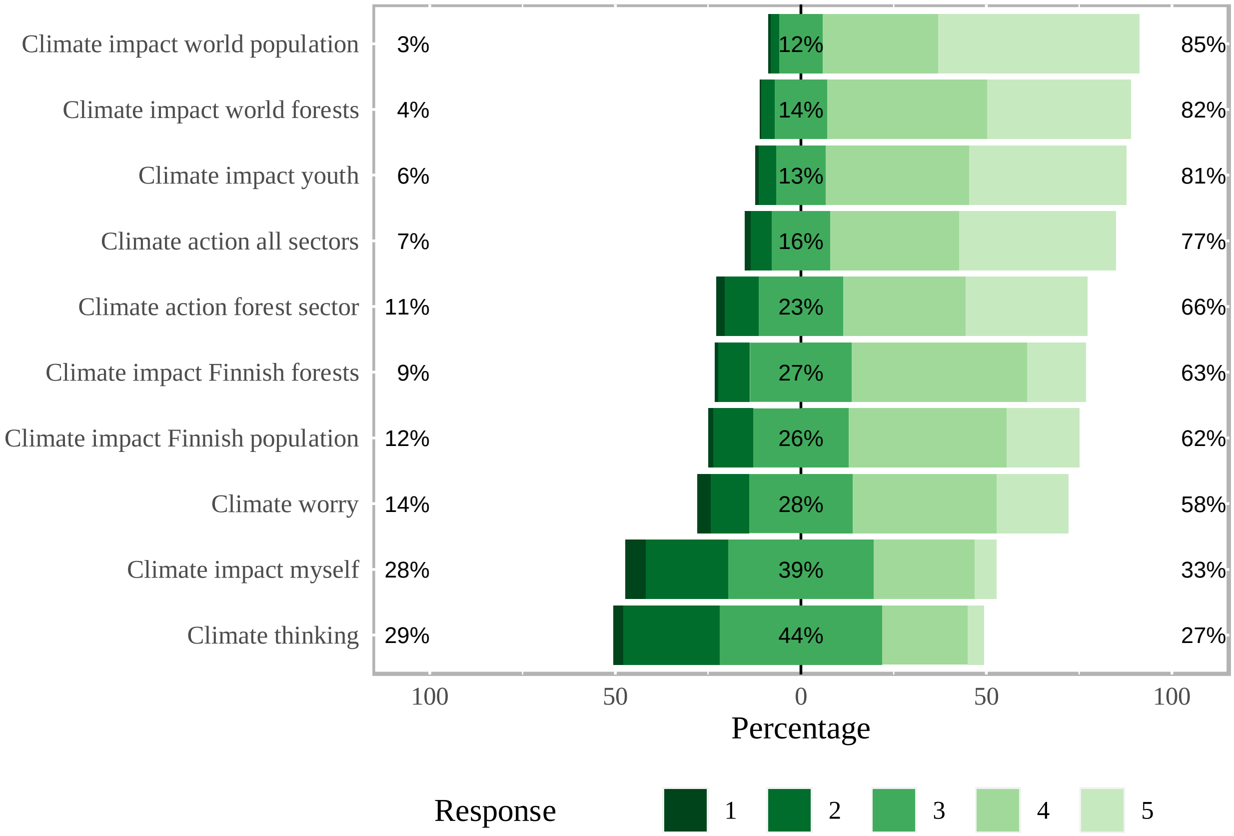

Figure 1. Distribution of responses for variables measuring worry about climate change, frequency of thinking about the consequences of climate change, the believed impacts of climate change, and the need for climate change mitigation. The percentages on the side represent the distribution of responses on that side of the Likert scale, i.e., either 1 (=e.g., “not at all worried”) and 2 or 4 and 5 (=e.g., “very worried”). The percentages in the middle show the distribution for the middle responses.

Regarding the most important value affecting the choice between the alternative climate change mitigation strategies in the forest sector (Figure 2), a third of the respondents (33%) ranked (low) costs of a strategy as the most important, followed by the effectiveness of a strategy to mitigate climate change and the effect of a strategy on biodiversity, perceived equally important (21%). Almost every fifth respondent (18%) ranked the effectiveness of a strategy to reduce damage and diseases as the most important value affecting the choice between the alternative climate change mitigation strategies in the forest sector, and the share of respondents by which it was ranked as the least or second least important value was the smallest, in comparison to other values. The effects of a strategy on the local economy were seen as the lowest priority.

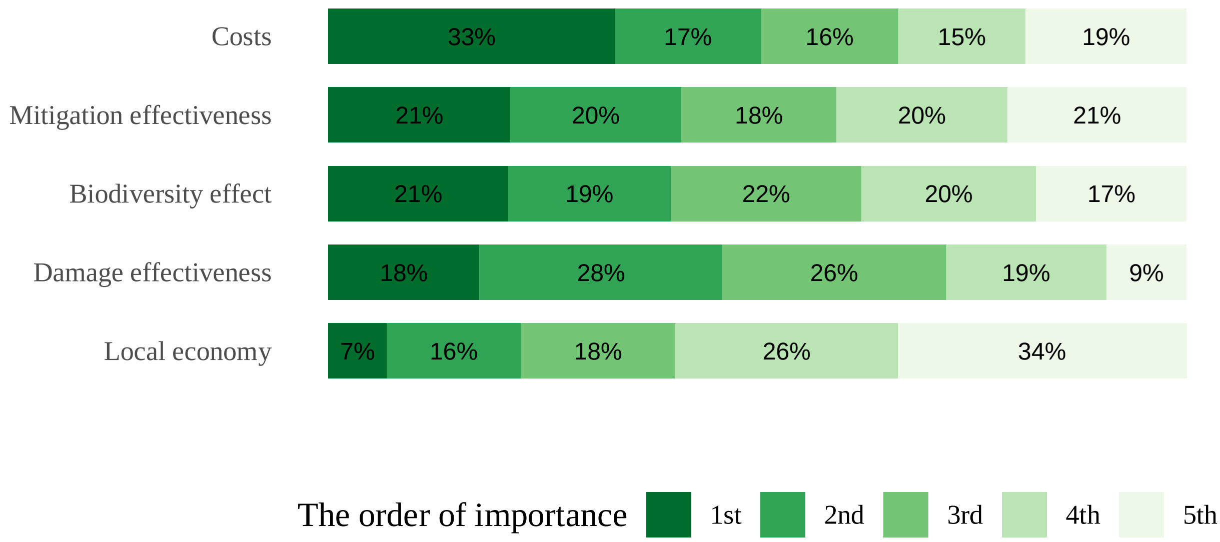

Figure 2. Ranking in order of importance from most to least important value affecting the choice between the alternative climate change mitigation strategies in the forest sector.

3.2.4 Data modification – hypothesis variables

All hypothesis variables, except the variable regarding believed climate cause (part of the risk perception hypothesis H2) and size of forest land (H5), were modified for further analysis. First, modification was required for education and political orientation variables. Education levels were combined into two groups called "university" and "other". The group university consisted of only respondents who have a university degree and the other group consisted of respondents with all other levels of education i.e., from elementary school to university of applied sciences. With this type of distribution, the division of observations in both groups was sufficient. Further, even though the university of applied sciences is a higher education institution, the choice of division could be justified by the fact that the university is the highest recognized institution in Finland.

Based on the average coordinate positions of the parties in the three most recent parliamentary elections (see Figure 3), the party support of each respondent was coded into two variables: GAL or TAN and left or right. The limited number of observations in each category in GAL-TAN and left-right space led to the lack of the middle-category that is commonly used in the studies (e.g., Isotalo et al., 2020), and the division of the space in two instead of three. The group "GAL" consisted of the Greens, the Left Alliance, the Swedish Peoples' Party, the National Coalition Party, and the Social Democratic Party (located below the dashed line (point 5) in Figure 3), while the remaining three parties formed the group “TAN”. The group “left” consisted of the Left Alliance, the Greens, and the Social Democratic Party, whereas the rest of the parties formed the group “right”.

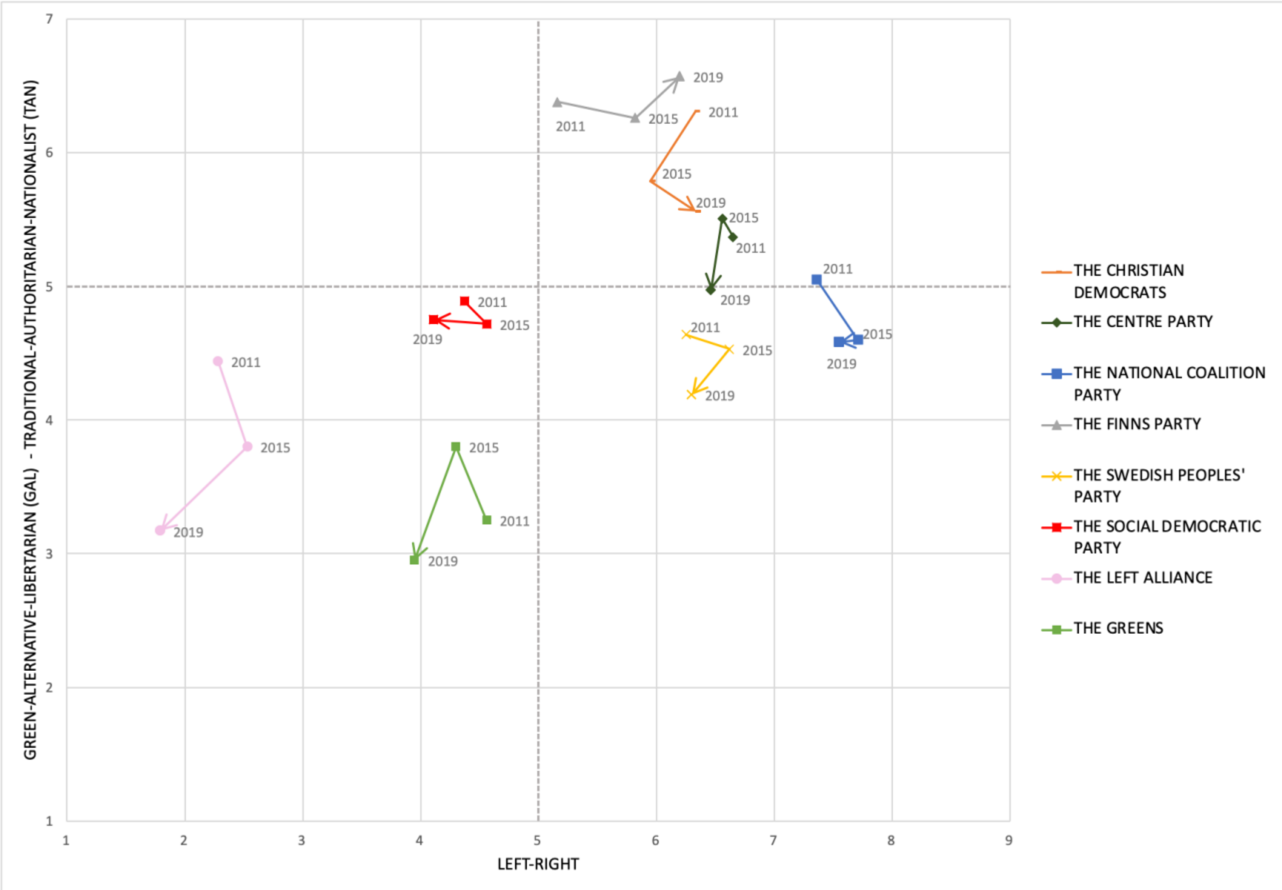

Figure 3. The average positions of the Finnish parties in a two-dimensional political space (Isotalo et al., 2020, p. 300).

The variables measuring worry about climate change (question 8), the frequency of thinking about the possible consequences of climate change (question 9), and the believed impacts of climate change (question 10), were factor analyzed (see more about factor analysis in 4.1) to reduce the number of independent variables in further analysis. These variables were indeed found to reflect the same perceptions on climate change, as all variables loaded well on a factor. The correlation matrix and the result of the factor analysis can be seen in Appendix 3 and 4, respectively. The resulted factor was named “perceived risk of climate change”, forming a composite risk score for each respondent. Furthermore, analysis of the perceived risk of climate change factor and the considered importance of climate change mitigation (question 11), revealed a strong correlation between them, both with regard to all sectors (Pearson $r=0.77$, $p<0.001$) and the forest sector (Pearson $r=0.75$, $p<0.001$). Due to the high correlation, only the perceived risk of climate change factor was included in the further analysis. Finally, regarding the values affecting the choice between the alternative climate change mitigation strategies in the forest sector (question 13), only the value that was ranked as the most important by each respondent was used in further analysis.

4 Methods

4.1 Exploratory factor analysis

Exploratory factor analysis (EFA) provides a tool for example for reducing the number of independent variables in the regression as well as for reducing the number of categories in the dependent variables. A factor analysis was conducted for independent variables measuring worry about climate change, the frequency of thinking about the possible consequences of climate change, and the believed impacts of climate change, resulting in the factor "perceived risk of climate change" presented in 3.2.4. This section focuses merely on the factor analysis implemented for the dependent variables i.e., the climate change mitigation strategies in the forest sector, as those are the core of this study. Nevertheless, the factor analysis for the perceived risk of climate change was executed similarly as explained in this section.

The association between different variables was examined by conducting an EFA to understand whether these strategies represent any analogous concepts (Fabrigar & Wegener, 2011). Indeed, factor analysis is a useful procedure when the aim is to reduce the number of observed measures by combining them into distinct categories called factors. The correlations provide an idea of whether the measures can represent the same concept. Therefore, according to Metsämuuronen (2011), some measured variables should have at least a correlation of 0.3 for sensible results from factor analysis. This requirement was met (see Appendix 5) and the factor analysis was executed.

The analysis was conducted exploratively since no clear predictions on the number of factors were known. Even though, in the study by Peterson St-Laurent et al. (2018) two factors were formed, this study was conducted in a different setting, making it unclear how the strategies will cluster. Thus, to test the number of factors in the factor analysis, three tests were implemented. According to the Kaiser criterion (originally proposed by Kaiser, 1960), the number of eigenvalues greater than one defines the number of factors to be extracted. Based on this procedure the appropriate number of factors was one. Scree test (originally proposed by Cattell, 1966) on the other hand is based on a visual interpretation of a graph where eigenvalues lie in descending order. The number of factors is determined based on the number of eigenvalues before the graph starts to stabilize. This test suggested two factors as the most suitable number. Finally, a parallel analysis (originally proposed by Horn, 1965) was conducted which suggested the use of two factors. The idea of parallel analysis lies in the comparison of eigenvalues from real data with the corresponding eigenvalues from random data. The number of factors is then determined with the number of eigenvalues from the real data that are greater than the corresponding eigenvalues from random data.

Both Maximum Likelihood (ML) and Principal Axis (PA) methods were used to conduct the analysis. However, similar results were obtained with both procedures, and thus only the ML results were reported, as it is often seen as the most preferable fitting procedure due to its additional information (Fabrigar & Wegener, 2011). If the data is broadly normally distributed and important factors are not expected to be weak, ML is a suitable method (ibid.). The analysis was run with two rotations, Varimax and Promax. Varimax is an orthogonal rotation whereas Promax is an oblique rotation assuming correlation between factors (Fabrigar & Wegener, 2011). First, the analysis was implemented with Promax rotation, but since no correlation between factors was found, the analysis was reiterated with Varimax rotation. The reported results are thus based on Varimax rotation. Further, a minimum loading of 0.4 was acquired, which was also used by St Peterson et al. (2018). Cronbach's alphas were calculated to measure the internal consistency and the minimum accepted value was set to 0.6, which has generally been considered as the boundary value (Metsämuuronen, 2011).

4.2 Linear regression analysis

To understand the correlation between dependent (i.e., the groups of strategies resulting from factor analysis) and independent variables, multiple linear regression analysis was conducted. Regression analysis is best suited for situations where the explanatory power of certain known variables is to be tested (Metsämuuronen, 2011). Thus, since the hypotheses were derived from existing literature, regression was seen as the most suitable method for this study. Linear regression was chosen, as the relationship between the response variables and the explanatory variables was assumed to be linear (Goos & Meintrup, 2016).

The idea of the regression analysis was to test the effect of hypothesis variables on the dependent variables. R^2, explains how much independent variables explain the variation in dependent variables (Metsämuuronen, 2011). The Adjusted R^2, which includes additional information about sample size and the number of variables, was used to explain the contribution of independent variables to the level of support for mitigation strategies (ibid.). In the presentation of the regression models, beta coefficients, statistical significances, and error terms are reported. Beta coefficient explains the strength of the effect of an explanatory variable on the dependent variable (Metsämuuronen, 2011). In addition, R^2 and the adjusted R^2 are reported for each model. The significance level of all statistical tests and analyzes was predetermined to be $p<0.05$.

The following independent variables were inserted into the models: age, gender, region, occupation, education, the prioritized value, belief in the cause of climate change, perceived risk of climate change (factor), GAL-TAN political orientation, left-right political orientation, education*GAL-TAN political orientation (interaction), education*left-right political orientation (interaction), and forest holding size. Age, gender, region, occupation, and education formulated the base of the models, to which other variables were added to obtain the full models. Models were run separately for the outcome variables.

Given that the whole purpose of the regression analysis was to test the hypotheses, the full models were used since they include all the hypothesis variables. Nevertheless, reduced models were provided for further research purposes. With backward elimination, the variables were omitted until the Akaike information criterion (AIC) of the model did not further decrease. AIC is used in the comparison for different models, where the model with the lowest AIC better corresponds to the data (Metsämuuronen, 2011). Therefore, the models with the lowest AICs formed the reduced models. Certainly, the reduced models are also valuable in understanding the significant and the most important variables that explain the variance in dependent variables. However, from the point of view of the hypothesis testing in this study, the full models were considered more important.

The generalized variance inflation factors (GVIF) were calculated for independent variables to check for possible multicollinearity. However, Fox & Monet (1992) suggest taking the GVIF to the power of 1/2df, which takes into consideration the different levels of categorical variables. These values ranged from 1.04 to 2.89, giving no grounds for multicollinearity (see Appendix 6).

The fitted regression models were further analyzed with regression diagnostics, the results of which can be seen in Appendix 7-8. Based on the regression diagnostics regression assumptions of linearity of the data, normality of errors, homoscedasticity of variance, and independence of residual error terms, were all met (Yan & Su, 2009). Linear regression assumes a linear relationship between the dependent variable and the explanatory variables (Yan & Su, 2009). This can be observed from the Residuals vs. Fitted plot where a horizontal line with a random pattern bespeaks linearity. Residuals can be considered normally distributed if they are approximately positioned on a straight line in the normal quantile-quantile plot (Metsämuuronen, 2011). Homoscedasticity on the other hand can be seen from the scale location plot, where evenly distributed residuals are a sign of homoscedasticity (ibid.). Independence of residual errors refers to an assumption that observations in the data are random, correspondingly leading to unrelated error terms (Yan & Su, 2009). Yan & Su (2009) further state that the independence assumption can be assumed to hold true if the data has been randomly collected. Outliers were analyzed with Cook’s distance, according to which the larger the distance of a single observation the more effect it has on the beta coefficients (Metsämuuronen, 2011). Albeit, all extreme observations stayed outside of Cook’s distance boundaries, the regression was repeated without the three most extreme outliers. However, the fit did not drastically change and thus all points were kept in the analysis.

5 Results

5.1 Support for climate change mitigation strategies in the forest sector

On average, all presented climate change mitigation strategies in the forest sector were supported by forest owners except for the "Less harvest" strategy (Figure 4). High mean values and somewhat skewed distribution of responses for "Wood products" and "Adaptation" strategies gave rise to a doubt of whether these strategies divide forest owners sufficiently to be sensible to include them into the analysis. Further, looking at these strategies' standard deviations (Wood products: SD=0.77, Adaptation: SD=0.73) supported their exclusion from the analysis (see Appendix 9 for response frequency distributions (bar plot) and Appendix 10 for descriptive statistics of the strategies).

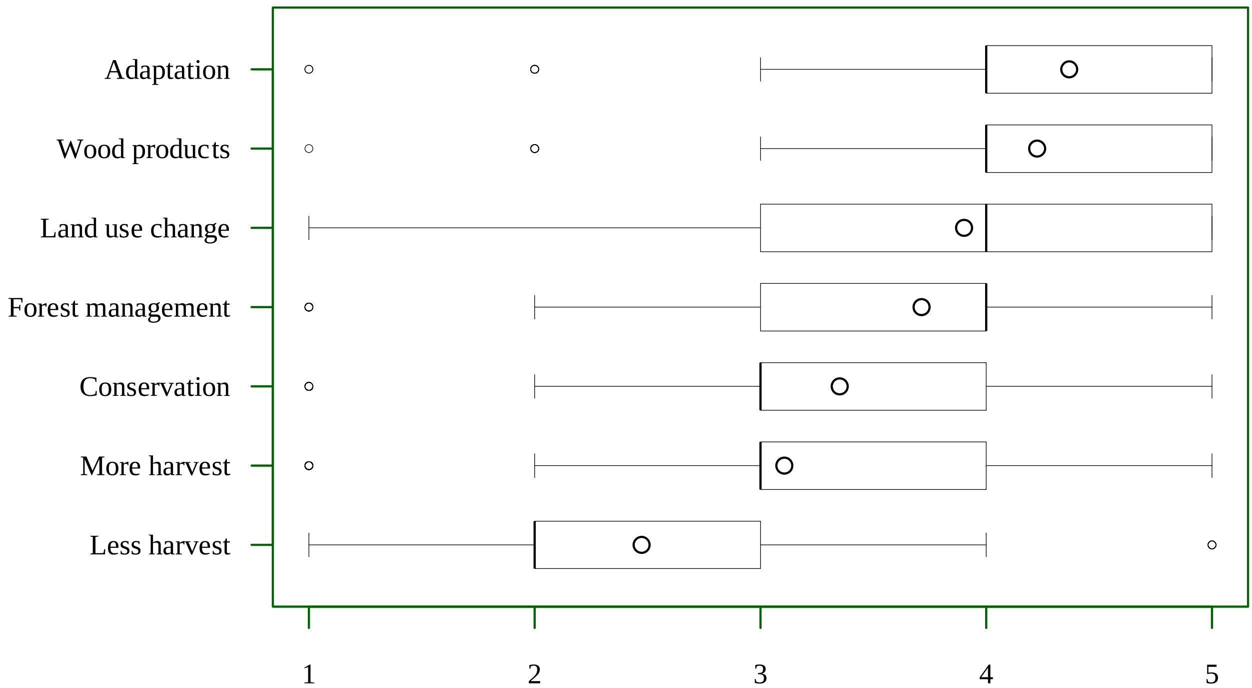

Figure 4. The response distribution of support or opposition for different strategies. The 'box' refers to the middle half of the responses and the 'whiskers' refer to the upper and lower quartiles. The black circle inside each box plot refers to the mean value; the darker, vertical line to the median value; and the small circles on the side refer to possible outliers. 1= "strongly resist" and 5= "strongly support".

5.2 Obtaining strategies for hypothesis testing through factor analysis

To explore further the climate change mitigation strategies in the forest sector (in Figure 4), several exploratory factor analyses were run with varying numbers of factors extracted and with a different set of mitigation strategies (items) included in the analyses. Table 4 illustrates the results when two factors were extracted. The only admissible factor included the following three items: More harvest, Less harvest, and Conservation. All these strategies had high loadings (>0.72) on a factor and the Cronbach's alpha (α) of 0.81 was considered good. Despite that the loadings of all strategies were adequate, the Cronbach's alpha of the other factor remained clearly below the satisfactory level at 0.52. Further, it could not be improved by excluding any strategy from the analysis.

Table 4. Factor loadings of forest owners' support towards climate change mitigation strategies.

Strategy	**Loadings**	
	Factor 1 (α= 0.81)	Factor 2 (α= 0.52)
More harvest	-0.74	
Less harvest	0.87	
Conservation	0.72	
Wood products		0.50
Land-use change		0.47
Forest management		0.43
Adaptation		0.42

As was discovered earlier (chapter 5.1), Adaptation and Wood products did not divide forest owners as much as the rest of the strategies. When these two strategies were removed and the analysis was repeated extracting two factors, Land use change did not load on either of the factors (loading <0.4). When Land use change was removed and the analysis was repeated extracting only one factor, Forest management did not load on the factor. As a result of multiple factor analyses, it became clear that only one strong factor emerged and should be selected for further analysis.

The formed factor was named "Less intervention", representing an imagined spectrum from -2 to 2, where negative values indicate support for more intervention and positive values for less intervention. Less intervention was used as the dependent variable in the regression analysis to study the effects of hypothesis variables on the support for strategies with different levels of human intervention in forests. Forest management had sufficient loadings in all experimented factor analyses (except the last one) and the frequency distribution of responses (Appendix 9) showed that the strategy appeared to significantly divide forest owners. Therefore, it was selected as an individual strategy for further analysis as a basis for comparison to both the Less intervention strategy per se, and the study by Peterson St-Laurent et al. (2018) who had a similar distribution of strategies.

5.3 Hypothesis testing with regression analysis

The results of the linear regression analysis of the effect of hypothesized variables (Chapter 2) on the support for selected climate change mitigation strategies in the forest sector, i.e., Less intervention and Forest management, are presented in Table 5. For other models with different combinations of explanatory variables, see Appendix 11-13. A positive sign of the beta coefficient indicates a positive relationship, i.e., an increase in the independent variable is associated with an increase in the support towards the strategy, whereas a negative sign of the beta coefficient indicates a negative relationship. Confidence intervals of the two models can be seen in Appendix 14.

Table 5. Multiple linear regression models for Less intervention and Forest management. Reference levels for categorical variables: Gender – female, Region – Uusimaa, Occupation – wage earner, Education – other, Political orientation (GAL-TAN) – GAL, Political orientation (left-right) – left, Cause – anthropogenic, Prioritized value – biodiversity effect.

	LessInt Model	**ForestMgmt Model**
(Intercept)	**1.08 (0.12)***	**-0.86 (0.16)***
Age	-0.02 (0.04)	-0.07 (0.05)
Gender - male	**-0.26 (0.06)***	**0.30 (0.08)***
Gender - prefer not to say	-0.08 (0.38)	-0.61 (0.50)
Region - North Karelia	-0.14 (0.07)	-0.07 (0.09)
Region - Päijät-Häme	**-0.19 (0.07)**	0.03 (0.10)
Occupation - agricultural entrepreneur	-0.13 (0.12)	0.02 (0.15)
Occupation - other independent entrepreneur	0.01 (0.08)	0.11 (0.11)
Occupation - other	-0.05 (0.13)	**-0.38 (0.17)**
Occupation - pensioner	-0.07 (0.08)	-0.01 (0.10)
Education - university	**0.27 (0.12)**	0.12 (0.16)
H1 Prioritized value - costs	**-0.49 (0.07)***	**0.30 (0.10)**
H1 Prioritized value - local economy	**-0.47 (0.11)***	0.27 (0.15)
H1 Prioritized value - mitigation effectiveness	**-0.23 (0.08)**	**0.34 (0.10)***

H1 Prioritized value - damage effectiveness	**-0.45 (0.08)*****	**0.37 (0.11)*****
H2 Cause - anthropogenic/natural	-0.07 (0.06)	-0.06 (0.08)
H2 Cause - natural	-0.22 (0.14)	-0.29 (0.18)
H2 Cause - do not know	0.09 (0.20)	0.28 (0.26)
H2 Cause - not true	-1.18 (0.74)	1.72 (0.98)
H2 Perceived risk of climate change	**0.18 (0.03)*****	**0.12 (0.04)****
H3a Political orientation (GAL-TAN) - TAN	-0.07 (0.09)	0.10 (0.12)
H3b Political orientation (left-right) - right	**-0.49 (0.12)*****	**0.38 (0.16)***
H4 University: TAN	-0.01 (0.11)	-0.05 (0.15)
H4 University: Right	**-0.34 (0.14)***	0.03 (0.19)
H5 Total forest land	**-0.07 (0.03)****	0.01 (0.03)
R^2	0.41	0.11
Adj. R^2	0.39	0.09
Num. obs.	892	892

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

The goodness of the fit for the LessInt Model was just below 40% (Adjusted R^2= 0.392), whereas that of the ForestMgmt Model was just below 10% (Adjusted R^2= 0.088). In addition to the intercept, the most significant explanatory variables in the LessInt Model were the following: gender male to the reference level female; prioritized values costs, local economy, and damage effectiveness to the reference level biodiversity effect; perceived risk of climate change; and political orientation (left-right). In the ForestMgmt Model, the most significant variables, in addition to the intercept, were the following: gender male to the reference level female; and prioritized values mitigation effectiveness and damage effectiveness to the reference level biodiversity. In the LessInt Model, other significant variables were region Päijät-Häme to the reference level Uusimaa; education; prioritized value mitigation effectiveness to the reference level biodiversity effect; the interaction term of education*political orientation (left-right); and the size of the forest land. In the ForestMgmt Model, other significant variables were occupation other to reference level wage earner; prioritized value costs to the reference level biodiversity; perceived risk of climate change; and political orientation (left-right).

Regarding the hypothesis on prioritized values (H1), that is, the forest owners prioritizing economic values support strategies with more human intervention, all prioritized value variables were negatively associated with Less Intervention in reference to the biodiversity effect. This supports hypothesis H1, meaning that forest owners who value factors other than biodiversity effect (e.g., economic values) are, on average, more supporting towards strategies with more human intervention. Even though all prioritized value variables were statistically significant, costs and local economy had the strongest opposite beta coefficient from the biodiversity effect. Similarly, hypothesis H1 is supported by the results of the ForestMgmt Model. However, in the ForestMgmt Model, only three prioritized value variables (all except local economy) were significant, yet all had a positive association with support towards forest management in reference to biodiversity effect. This means that, on average, forest owners who prioritize values other than biodiversity effect are more likely to support Forest management as a climate change mitigation strategy.

Regarding the risk perception of climate change (H2), that is, the forest owners who worry about climate change and are more concerned about the impacts of climate change are more likely to support mitigation actions, the model results support the hypothesis. The evaluation of the hypothesis consisted of two variables. Firstly, the perceived risk of climate change factor was studied, finding a significant positive association with both Less intervention and Forest management. Hence, a higher perceived risk score resulted in more support towards strategies with Less human intervention as well as in support towards Forest management. This shows that the hypothesis H2 is supported by the findings, as a higher risk perception score can be associated with more support towards mitigation strategies in general. Perceived risk was found to be the only variable having an aligned effect on both Less intervention and Forest management. Yet, the effect was slightly less significant for Forest management.

Secondly, the association between the belief in the cause of climate change and the support towards mitigation strategies was examined. This variable was not found to be significant in explaining variance in support for either Less intervention or Forest management. Notwithstanding the non-significance towards the output variables, it was found to greatly affect the perceived risk of climate change factor, i.e., the other variable used to test H2. Forest owners who believe in the anthropogenic cause of climate change were found to have significantly higher risk scores compared to those who believe in any other cause of climate change (see Table 6). When interpreting the results in Table 6, it is important to note that the data used in this regression model includes only one respondent who did not believe in climate change at all, and thus the distinct difference in beta coefficient should be interpreted with caution. Even so, the difference between human-caused climate change and all other causes is significant, showing that the belief in the cause of climate change strongly affects the overall risk perception.

Table 6. The effect of the belief in the cause of climate change on the perceived risk of climate change factor.

	Perceived risk of climate change
(Intercept)	**0.34 *** (0.03)**
Cause - anthropogenic/natural	**-0.69 *** (0.06)**
Cause - do not know	**-1.88 *** (0.14)**
Cause - natural	**-2.02 *** (0.20)**
Cause - not true	**-3.98 *** (0.81)**
R^2	0.31
Adj. R^2	0.30
Num. obs.	892

$^{***}p < 0.001$

Hypothesis H3 was twofold about political ideology. Firstly, H3A assumed that forest owners who consider being positioned more on the GAL side (e.g., esteem green and liberal values) of the GAL-TAN spectrum, are more likely to support mitigation strategies with less human intervention. Secondly, H3B assumed that forest owners who consider themselves more as right-winged on the left-right spectrum are more likely to support mitigation actions with more human intervention. Out of these two measures of political orientation, in both models only left-right orientation was significant. The relationships had the assumed signs, supporting hypothesis H3B. Variable GAL-TAN was not significant, providing no evidence that the position on the GAL-TAN spectrum would affect the level of support for either of the strategies. Therefore, in the light of this study, the hypothesis H3A was not supported.

Regarding the interaction between education and political ideology on the support for climate change mitigation strategies (H4), the hypothesis is supported by the LessInt Model but not by the ForestMgmt model. The interaction term with left-right political orientation had a significance in the LessInt Model. The interaction indicates that forest owners with a university degree and left-winged political orientation have a tendency towards mitigation strategies with less human intervention in forests, whereas the forest owners with a university degree but right-winged political orientation have a tendency towards strategies with more human intervention in forests.

Regarding the effect of the size of forest property on the level of support for mitigation strategies (H5), that is, the forest owners with larger property support strategies with more human intervention, the LessInt Model provides support for the hypothesis. While in the LessInt Model, a slightly negative association was found, the ForestMgmt Model did not provide further support for hypothesis H5. The forest land size did not have any statistically significant effect on the support for Forest Management strategy, as the p-value was very large while the beta coefficient near zero.

Figure 5 summarizes the findings regarding hypothesis testing (Table 5) and includes all independent variables that were statistically significant ($p<0.05$) in either of the regression models (LessInt and ForestMgmt). The effects in the models were largely opposite, yet the significance levels varied. Concerning the statistically significant variables, only the perceived risk of climate change variable had an aligned effect on both strategies. The belief in the cause of climate change was not found significant in explaining the support towards different strategies, however, it was found to greatly affect the overall risk perception of climate change.

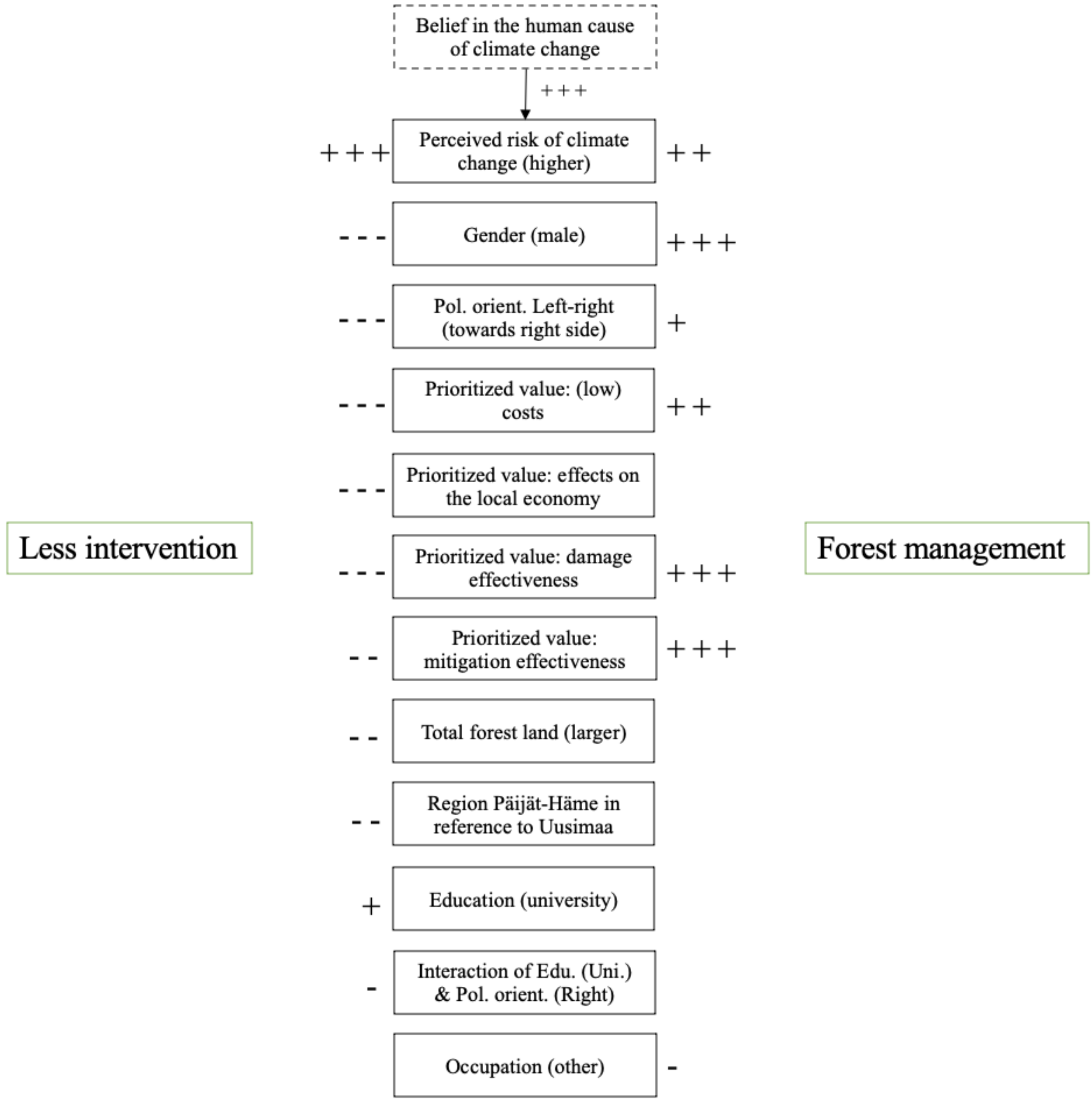

Figure 5. Illustration of the statistically significant variables on the support for Less intervention and Forest management. "+" sign indicates a positive relationship and "-" sign a negative relationship towards the output variable. The number of signs refers to the significance level where one sign is $p<0.05$, two signs $p<0.01$, and three signs $p<0.001$. Note that prioritized values are significant in reference to the biodiversity effect of a strategy.

6 Discussion

6.1 Support for climate change mitigation strategies

The purpose of this research was to provide new information on the sociodemographic and attitudinal variables that affect the support or opposition for different climate change mitigation strategies in the forest sector among Finnish forest owners. A total of seven strategies was examined: Forest management, More harvest, Less harvest, Conservation, Wood products, Adaptation, and Land use change. As a result of the factor analysis, two groups of strategies were formed and used in the further analysis: Less intervention, which was a combination of three strategies, and Forest management, which was an individual strategy. Through the use of linear regression analysis, the effect of hypothesized variables on the support or opposition toward these resulted strategies (i.e., Less intervention and Forest management) was examined. Furthermore, a more general aim was to discover how the different strategies resonate among forest owners. This was examined through simple descriptive statistics to obtain the average support or opposition for each strategy.

Regarding the support for different climate change mitigation strategies in the forest sector, on average all other strategies, except the Less harvest strategy, were supported by the forest owners. This is contrary to the results of the Canadian study by Peterson St-Laurent et al. (2018) in which all strategies were supported. One potential reason for the difference could be that, in this study, the respondents were forest owners, whereas respondents of the Canadian study were ordinary citizens. An interesting finding was the popularity of Adaptation to climate change and Wood products as climate change mitigation strategies among Finnish forest owners. One explanation could be that neither of the strategies requires large adjustments to the traditional timber-focused management style in Finland. By the same token, the Less harvest strategy could be seen as a threat to timber supply and thus not supported. Apart from Less harvest, Conservation could be regarded as set-aside conservation areas, whereas decreased harvests are directly interrelated with decreased wood supply. This may explain why Conservation was on average supported, but Less harvest was not. Furthermore, our results revealed that a larger forest holding size can be associated with more human intervention in forests, and the average forest holding size in our study was considerably higher than the national average, which might explain the less support towards Less harvest. The finding is analogous with previous studies arguing that larger forest holding is often of greater economic importance to the owner, leading to a more intensive management style (Aguilar et al., 2014; Eggers et al., 2014; Juutinen et al., 2020).

Regarding the linkages between different strategies, one could expect the continuum from less intervention to more intervention. Unlike was presumed and seen in the study by Peterson St-Laurent et al. (2018), two factors were not formed in the factor analysis to represent the two ends of the same dimension, measuring the intensity of human intervention in forests. Even though Less intervention and Forest management seem, to some degree, to explain the same phenomenon and vary in the level of human intervention, it appeared that they cannot be positioned on the same continuum as such. The phenomenon is similar to left-right and GAL-TAN spectrums, i.e., two ways for measuring political orientation: even though they explain somewhat the same issues, they are two different dimensions in the same political space. In the light of these results, it appears difficult to precisely express how the respondents have perceived the differences in climate change mitigation strategies that were presented to them in the survey questionnaire. The research frame, where the dependent variables of the models were partially overlapping caused this ambiguity in interpretation. However, naturally, the strategies contain some duplication and tradeoffs also in real life.

6.2 Factors affecting the support for strategies

The results of the study highlight that forest owner's political orientation can affect the level of support for climate change mitigation strategies in the forest sector. However, only the left-right political dimension was significant in our analysis. This could be explained by the more established role of the left-right dimension compared to the newer and more ideology-focused GAL-TAN dimension (Isotalo et al., 2020). Furthermore, on the GAL-TAN dimension, parties position more in the middle, whereas on the left-right dimension, parties are more widely distributed. Thus, the distribution of parties to two extreme groups of the dimension, to either GAL or TAN group, is not as divisive as it is for the left-right dimension. Moreover, the finding concerning the stronger effect of education for left-winged forest owners on the support for Less intervention was supported in this study, consistently with the previous scientific literature (e.g., Czarnek et al., 2021; McCright et al., 2015). In other words, a higher education level does not explicitly explain the support towards certain strategies, since the effect of education alters as a function of political orientation.

In Finland citizens' political orientation has changed within the past decade (Isotalo et al., 2020). People are getting further apart from each other in terms of political ideologies and are less often placed in the middle of the left-right dimension (ibid.). This bespeaks that some degree of polarization is occurring among voters, yet, in Finland, this trend has not been extensive and differences between ideologies are still considered mild (ibid.). Nevertheless, our findings could partly support the notion of deepening polarization, as political orientation affected the support towards different strategies. Polarization is problematic especially with urgent and potentially highly consequential issues like climate change mitigation. It is known to cause discord and hinder policy implementation (Farrell, 2016). In the US, for instance, climate change is a highly polarized issue, Democrats generally lending support for climate change mitigation actions, whereas Republicans not (McCright, & Dunlap, 2011). Yet, climate change is increasingly becoming part of the politics also in Finland. For instance, climate change was one of the leading themes in the 2019 parliamentary elections, as parties canvassed with questions related to climate change and the urgency of climate change mitigation actions (Eskonen, 2019). Therefore, even though strong signs of polarization are not yet visible in Finland, changes in political orientation could complicate the implementation and functionality of climate change mitigation strategies in the future. The further away parties' political ideologies separate, the more conflicts arise, and different values such as economic and environmental could increasingly divide people. Yet, it shall be noted that this study examined the effect of political orientation only on the support for various climate change mitigation strategies in the forest sector, and not on other factors such as risk perception, or the prioritized values that affect the choice between strategies. Thus, more research on the effects of political orientation on forest owners' decisions is needed.

The effect of sociodemographic variables on the support towards the strategies was also studied, yet not many of these variables were found highly significant in our study. For example, oftentimes, agricultural entrepreneurs have been found to support traditional timber supply-focused forest practices (Juutinen et al., 2020; Hänninen et al., 2011). However, in our study, the effect of occupation was barely noticeable. Only when examining the regression results for strategies individually, the effect was significant in the Conservation model, where agricultural entrepreneurs were on average less supportive towards conservation, compared to wage earners. Yet, the effect was not significant in the LessInt or ForestMgmt Models. Furthermore, education was only significant in the LessInt Model, indicating that those with a university degree were more likely to support strategies with less intervention in forests. This is somewhat comparable to earlier studies that have discovered that higher educated forest owners are less supportive of intensive harvests (Juutinen et al., 2020) and favor conservation actions of forests (Eriksson, 2012). This could be explained by the understanding that higher educated forest owners could see intensive harvests as harmful for other ecosystem services (Juutinen et al., 2020).

Gender was, nevertheless, found to be a highly significant predictor in both LessInt Model and ForestMgmt Model. Compared to men, women were more supportive towards Less intervention strategies and more opposing towards Forest management. Earlier research supports this finding by showing that female forest owners have been customarily more supportive towards conservation practices (e.g., Nordlund et al., 2010) and that the objectives regarding forest use vary between male and female forest owners (Umaerus et al., 2019). Regardless, the concept of female forest owners is relatively new as women have been categorized as a class of forest owners only since the beginning of 2000, resulting in a lack of research on this group distinctly (Follo et al. 2017). Active harvesting, which has long been the main use of forests, has been considered traditionally as a masculine activity, and women who own forests together with their spouses have often assimilated a more inactive role regarding the decisions of their forests (Vainio & Paloniemi, 2013). Yet, not all previous findings lend support to the more pro-environmental perceptions of female forest owners. For example, Vainio & Paloniemi (2013) and Hamunen et al. (2020) found that traditional harvesting activities were favored among female forest owners in the same way as among male forest owners. Similarly, Liedstav and Ekström (2000) discovered no difference in the amount of timber harvested between female and male forest owners, albeit harvesting activities occurred less frequently among female forest owners.

The values affecting the choice between the alternative climate change mitigation strategies in the forest sector were found to greatly affect the support towards the studied strategies. Respondents who prioritized low costs, mitigation effectiveness, or damage and disease effectiveness over biodiversity effect of a strategy, had on average less support towards Less intervention and correspondingly more support towards Forest management. Additionally, forest owners who prioritized the effects of a strategy on the local economy, over biodiversity effect, tended to support strategies with more human intervention in forests. Somewhat similar results were found, for instance, by Kline et al. (2000), who revealed that forest owners valuing nontimber objectives over timber objectives are more likely to renounce harvesting to reinforce biodiversity. Contrary, Eggers et al. (2014) argued that the choice of management strategy is not inevitably based on the objectives but more on the forest holding type. Furthermore, in our study, most of the forest owners ranked costs as the most affecting value when choosing between different climate change mitigation strategies. This was opposite to the study by Peterson St-Laurent et al. (2018), where more than half of the respondents identified costs as the lowest priority when selecting the strategies. In this study, the effects of a strategy on the local economy were seen as the lowest priority. Despite what is valued by the forest owners, previous research has revealed that many forest owners demand incentives to implement strategies that are not economically encouraging, such as conservation (Koskela & Karppinen, 2021) and increased carbon sequestration (Karppinen et al., 2018; Khanal et al., 2017). Incentive measures addressed to private forest owners have been studied to some degree, for example, the effect of carbon subsidy scheme on increased carbon sequestration in Finland (Juutinen et al.,2018; Laturi et al., 2015). However, there is still a need for further research on the area of how to encourage forest owners to implement these different climate change mitigation strategies.

6.3 Forest owners’ perceptions about the climate change

High risk perception was seen to affect the support for both Less intervention and Forest management strategies. Even though belief in the cause of climate change was not a significant variable in either of the models, it was found to greatly affect the perceived risk of climate change factor, thus impacting the overall risk perception. Individuals who believed in the human cause of climate change tended to have a higher perceived risk score. This is in line with other studies e.g., Gregersen et al. (2020) who studied the general publics’ worry about climate change across several countries in Europe, found that belief in anthropogenic climate change is a strong indicator of worry. This is only logical as the way risk is comprehended is found to alter based on whether the risk is natural or human-caused (Böhm & Pfister, 2017; Siegrist & Sütterlin, 2014). The same risk is often considered more threatening if the cause is, or is believed to be, anthropogenic. The followed level of action can also be affected by the origin of the cause as van der Linden et al. (2015) found that belief in the human cause of climate change suggests higher policy support.

This study confirms the largely noted association between risk perception and willingness to mitigate climate change: the more disastrous climate change is perceived the more willing one is to mitigate it (Peterson St-Laurent et al., 2018). Perceived risk of climate change was a significant factor in both Forest management and Less intervention models, and further in explaining the variance in each strategy independently. The higher the perceived risk score the higher the support towards the Less intervention strategies or alike support towards Forest management. Since Less intervention and Forest management are rather the opposite in terms of the level of human intervention, the result shows that individuals with high perceived risk generally support any strategies that help mitigate climate change. Yet, when observing the regression results for individual strategies, More harvest was the only strategy, the support of which was negatively affected by higher perceived risk score. This could arise from the notion that generally actions that decrease GHG emissions have been seen as the most beneficial for climate change mitigation in the short term (Lempriére et al., 2013). Therefore, those who are highly concerned about climate change might not consider More harvest itself as a strategy that would be beneficial for climate change mitigation in the short-term. Further, since the questionnaire included separately Wood product strategy which was explained as a strategy that would increase the production of longer-lived and lower-emission wood products, More harvest strategy might not have been seen to resonate with the same aim.

The majority (63%) of the respondents believed climate change to be mostly human-caused. This is similar to results from *Climate barometer 2019* (Ministry of the Environment, 2019), where around 75% of the Finns believed that climate change is mostly a result of human actions. Nevertheless, in total 94% of the respondents in our study believed climate change to be some degree anthropogenic, showing that Finnish forest owners appear overall relatively conscious about climate change. Furthermore, this finding is not very surprising as many surveys assigned for citizens have revealed the concern for climate change as well as the support and need for mitigation actions. For example, the results from *Climate barometer 2019* (Ministry of the Environment, 2019) showed that 70% of Finnish people considered that climate change mitigation should be the main priority for the government and over 40% stated that they will vote for a candidate (in 2019 parliamentary elections) who works actively to mitigate climate change. According to a survey conducted by Yle (public service media company) 99% of the Finns are of the opinion that climate change requires mitigation (Wallius & Terävä, 2020). It can be therefore concluded that the presence of climate change has been well realized by the Finns, and climate change mitigation is considered significant.

Despite the large consensus of the occurrence of climate change and the need for climate change mitigation, in an international comparison, Finland ranks fairly low in considering climate change extremely serious (Newman et al., 2020). According to the report by Newman et al. (2020), 57% of the Finnish sample considered climate change extremely serious, compared to, for instance, the sample from Chile where the corresponding share was 90%. However, all Nordic countries in the survey ranked low in terms of classifying climate change as very serious. Kim and Wolinsky-Nahmias (2014) note that despite climate change will affect the whole globe, the occurrence and level of harm varies from area to area. The visible changes of climate change in the Nordic countries have been quite minor to date, and thus an individual might not consider climate change as serious, compared to places that are vulnerable to climate change or where the impacts have already been notable. This raises from the notion according to which, the more individuals are able to feel the changes of climate change personally, the better they usually comprehend the risks of climate change (Akerlof et al., 2013). Furthermore, Sandvik (2008) discovered that people in countries with higher national wealth are less concerned about climate change, which could further explain the low ranking of Nordic countries in terms of climate change seriousness.

6.4 Reliability and validity

Reliability signifies how well the research process and the results of the study could be replicated (Leung, 2015). Reliability of the study was examined throughout the analysis to limit the probability of statistical error. For example, when conducting the factor analyses, the internal reliability of the extracted factors was tested with Cronbach's alpha. Alternatively, validity refers to whether a method is applicable to measure the intended phenomenon (Curtis & Drennan, 2013). The questionnaire was designed as simple and explicit as possible. Yet certainly, a possibility for misinterpretation or misunderstanding remains, causing observational errors. For example, the explanations about different climate change mitigation strategies were simplified, leaving a possibility that respondents with little or no knowledge of forest management could have found it difficult to answer this question and distinguish between the different strategies. The strategies in the survey were partly overlapping, thus making it impossible to know how the respondents have interpreted the resemblance and valued the strategies accordingly. Moreover, question setting about the belief in the cause of climate change did not specify the reference to climate change that is occurring during this century and some respondents might have responded referring to climate change that has occurred throughout history.

Regarding the goodness of fit of the models, even though both regression models were statistically significant (LessInt Model: $F(24, 867)=24.9$, $p<0.001$; ForestMgmt Model: $F(24, 867)=4.565$, $p<0.001$), the R^2 values differed greatly. The independent variables better explained the variation in LessInt Model (Adjusted R^2=0.39) than in ForestMgmt Model (Adjusted R^2 =0.09). Interestingly, the findings by Peterson St-Laurent et al. (2018) were almost identical as the Adjusted R^2 values were 0.39 and 0.10, respectively, for similar strategies. Some of the differences may be explained by the respondents' differing familiarities for strategies. Forest management is a complex strategy that could be understood to consist of multiple measures in the forest, yet the meaning of the strategy was only shortly described in the questionnaire. Moreover, the intensity and the effects of harvests have been a widely discussed and debated topic in Finland, potentially making the effects of the strategy on climate change mitigation more familiar to forest owners.

Furthermore, when comparing the explanation power in regression models, the difference could be explained by the so-called passive forest owners. As Khanal et al. (2017) state, forest owners can vary widely in relation to the level at which forest is managed. Since the respondents' role as forest owners was not examined in the survey, it remained unclear how forest owners have previously managed their forest land. Further, Juutinen et al. (2020) found a positive linkage between earlier employed practices and the perceptions about future forest management practices. Deriving from this, if the majority of the respondents prefer or have previously applied less intensive management styles in their forests or have not managed their forests at all, the independent variables in the model might not be best suited to explain the variation in support towards Forest management, resulting in a relatively low fit, as was the case in our study. Exploring forest owners' previous management strategies and overall objectives for forest ownership in relation to climate change views is an important area of further research.

Apart from information about previous management actions of forest owners, the analysis could have benefited from several additional variables that were not included in the current data. For example, there was no variable for the income of forest owner, the ownership type, location of residency, or information about the form in which the land has been obtained (e.g., purchased or inherited). Regarding the income of forest owners, Khanal et al. (2017) discovered higher income to have a positive linkage with delayed harvests. Haugen et al. (2016) showed that forest owners living at the forest estate are more likely to focus on the economic aspects of forests. When implementing the questionnaire, dependent variables were not yet determined, and thus the questions and the variables were not designed in regard to this study explicitly.

Certainly, a possibility for various types of bias exists, common in survey research. In anonymous surveys, there is no certainty that all respondents have given answers truthfully. For example, respondents' responses may be biased by socially desirable options, which could be chosen instead of reporting one's own perceptions and ideas (Ficko & Bončina, 2014; Lentillon-Kaestner et al., 2018). Yet this risk has been considered lower in self-administered than interviewer-administered surveys (Dillman, 2006). Bias could be also associated with a response style, for example, by strongly favoring the middle option of scale questions (Ficko & Bončina, 2014). Moreover, nonrespondents from the sample were not contacted to gain insights into the demographics of these people and the reasons behind not completing the survey. Thus, the respondents and the nonrespondents of the sample could differ in views and demographical attributes, leading to a possible nonresponse bias (Sax et al., 2003). Further research could be implemented to determine how much forest owner perceptions alter over time (Fallon, 2016).

Concerning the representativeness of the demographic characteristics and land size information of respondents, the data was compared to the nationwide *Finnish Forest Owner 2020* (Karppinen et al., 2020) study. For the most part, the distribution appeared fairly similar. Respondents with a university degree were more dominating in our study. Furthermore, regarding the representativeness with respect to political orientation, the distribution of party support was compared to the results of the 2019 parliamentary elections, interpreting each region separately (Official statistics of Finland, 2019). Especially the voters of the Social Democratic Party and the Finns Party were underrepresented in the study, whereas the voters of the National Coalition Party and the Centre Party were overrepresented. However, the data is not fully comparable, as forest owners’ party affiliation could vary from that of the general public.

It shall be pointed out that the sample used in this study was collected from three regions in Finland. However, these chosen regions differ by characteristics and thus the forest owners from these regions are considered valid to represent the whole forest owner population in Finland as such. The share of forest land from the whole land area is 83%, 70%, and 56% in North-Karelia, Päijät-Häme, and Uusimaa respectively (Luke, 2020). Also, according to a report by Lehtoviita et al. (2016) the importance of forest bioeconomy varies greatly by region. In North Karelia and Päijät-Häme forest bioeconomy plays a significant role for the local economy. In North Karelia, the share of forest bioeconomy from the total output is 13% or two times higher than the average by regions. In Päijät-Häme it accounts for 9% of total output, which is also higher than the average. Finally, in Uusimaa, the role of forest bioeconomy from total output is not proportionally high, yet on a national level, the output is major. Further, the results of the regression analysis defend the dissimilarity of the regions as Päijät-Häme was significantly different from Uusimaa ($p<0.01$).

If reliable population benchmarks exist, several statistical techniques (e.g., raking, matching, and propensity weighting) that correct for imbalances between the survey sample and the target population have been proposed (Mercer et al., 2018). Each technique assigns each respondent a weight so that the distribution of each variable imitates that of the target population (Kolenikov, 2014). However, while each technique carries not only merits, but also perils, and the available population benchmarks were still somewhat uncertain, such techniques were not applied in this study. However, this is something to consider in future studies on forest owners.

It is important to keep in mind that had the method of the study been different, could the results also differ. Since Forest management was treated in the regression analysis as a 5-point ordinal rating scale item, some might argue that linear regression is not then the most suitable method. Rating scale items have been criticized due to the assumption of equal distances between all consecutive items as some statisticians argue that the distance between "strongly oppose" and "oppose" cannot be assumed to be same the as the distance between "strongly support" and "support" (Harpe, 2015; Jamieson, 2004). If ordinal scale questions are assumed to have varying distances between items, ordinal logistic regression would be a more suitable method to be used. However, in this study, even distances between items were assumed and thus the implementation of linear regression analysis is justified.

In the questionnaire, the variable "party" was the only measure for political orientation. This variable had to be modified for data analysis to test the hypothesis of left-right and GAL-TAN orientations. However, given the original information about only the supported party, restricted options for analysis were available. Each party was identified as either GAL or TAN and left or right, which in reality is not very accurate since many of these parties lie in the middle, rather than at the extreme end of the spectrum. Also, no "middle"-category could be created because the number of observations in each category would not have been sufficient for comparison. This limitation could be tackled in future studies by treating the political variable as continuous, and instead of asking for specific party support, different questions about political ideology could be asked to give each respondent a unique point in the chosen political spectrum.

Furthermore, slightly over 40% of all respondents (when accounting for all 2179 responses), chose the option of "Other" or "Prefer not to answer" when asked about party support. Since political orientation was one of the main measures tested in the hypotheses, leaving this large set of respondents unnoticed could have an effect on the results. Nonetheless, when inspecting the group of respondents who did not determine their party affiliation, on average they were largely similar to the respondents of the analyzed group (892 responses). Only minor differences occurred in the distribution based on the sociodemographic factors, as compared to the analyzed group, the average

age was the same 57 years, gender distribution was nearly identical, around 80% had a higher education degree (university or university of applied sciences) (versus 85% in the analyzed group), and proportionally around 5% more respondents were from North-Karelia. Environmental values seemed to be slightly more important in the non-party-defining group, as biodiversity was ranked as the most important value by around 26% of the respondents, compared to 21% in the analyzed group. Contrary, costs, mitigation effectiveness, and damage effectiveness were slightly less prioritized among the non-party-defining respondents. Furthermore, on average Conservation was moderately more supported and Less harvest was less opposed, compared to the analyzed group. Correspondingly, other strategies were on average slightly less supported, whilst More harvest was marginally even more opposed than supported among the non-party-defining participants.

Lastly, it shall be noted that all of the steps in the data collection and analyzing process have been transparently reported, in order to provide the reader with the needed evidence to determine the quality of the study and the applicability of the findings to other contexts and studies (Heale & Twycross, 2015).

7 Conclusions

This thesis provided new information by examining Finnish forest owners' perceptions about the various strategies to mitigate climate change in the forest sector. Two broad strategies for forest-based climate change mitigation were identified: Less intervention and Forest management. Through the use of linear regression analysis, several variables were found to influence the forest owners' support for these two strategies. All hypotheses, presented in chapter 2, are to some degree supported by the findings from regression analysis. As one of the most significant and novel findings, the left-right political orientation affects the support for strategies: forest owners identifying themselves with parties that locate more on the right in the political spectrum, are more likely to support strategies with more human intervention in forests. Furthermore, to some extent, right-winged political orientation weakens the otherwise positive effect of education on the level of support for strategies with less intervention in forests. Notwithstanding, the effect of political orientation shall be further studied, incorporating multiple questions to comprehend forest owners' political ideologies in more detail.

This study lays the foundation for Finnish forest owner research from the perspective of climate change mitigation. Nonetheless, further research is needed to make stronger inferences about factors affecting the choice between alternative climate change mitigation strategies in the forest sector. Further research could, for instance, focus on how to motivate the forest owners to effectively implement these strategies. Incentive measures addressed to private forest owners have been studied to some degree, but more comprehensive research is needed in relation to different climate change mitigation strategies specifically. Finally, it would be fruitful to examine how other interest groups e.g., politicians, forest industry organizations, and scientists from different disciplines support these studied strategies.

In conclusion, Finnish forest owners are supportive of climate change mitigation actions. This suggests that in general policies that focus on climate change mitigation would be positively greeted among forest owners. However, earlier literature has shown the heterogeneity of forest owners regarding their characteristics, objectives, and decisions concerning forests. In this study, the heterogeneity of forest owners implied different levels of support for climate change mitigation strategies. In line with this, policies should be implemented with the aim to encourage the application of different climate change mitigation strategies among forest owners.

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Appendices

Appendix 1. Questionnaire questions

Background questions

1) *Age*

Scale: Numeric value

2) *Gender*
Scale: a) Male, b) Female, c) Prefer not to answer

3) *Highest level of education*

Scale: a) Elementary school, b) High school/Vocational school, c) University of Applied Sciences, d) University, e) Prefer not to answer

4) *Occupation*
Scale: a) Wage earner b), Agricultural entrepreneur, c) Other entrepreneur, d) Pensioner, e) Other

5) *Political orientation*
Scale: a) The Centre Party, b) The National Coalition Party, c) The Christian Democrats, d) The Finns Party, e) The Swedish Peoples' Party of Finland, f) The Social Democratic Party of Finland, g) The Left Alliance, h) The Greens, i) Other, j) Prefer not to answer

6) *Size of the forest holding (ha)*
Scale: Numeric value

Questions about climate change

7) *Do you believe that climate change… (choose only one)*

Scale: 1) is a result of mostly natural changes in the environment?, 2) is a result of mostly human-caused carbon dioxide emissions?, 3) is a result of both aforementioned equally?, 4) is not a result of either of the aforementioned causes, because climate change is not true?, 5) I do not know

8) *How worried are you about climate change on a scale from 1 to 5?*
Scale: 1=Not at all worried, 5=Extremely worried

9) *How often do you think about the possible consequences of climate change?*
Scale: 1=Never, 5=Daily

10) *To what extent do you believe that climate change will affect...*
    a) You personally?
    b) Young generations?
    c) Finnish people?
    d) The forests in Finland

e) The world population?

f) The world's forests?

Scale: 1=Not at all, 5=Extensively

Questions about climate change mitigation

11) How important do you consider climate change mitigation…

a) Across all sectors?

b) In the forest sector?

Scale: 1=Not important at all; 5=Extremely important

12) To what degree do you support or oppose the above-mentioned climate change mitigation strategies in the forest sector?*

a) Forest management measures

b) Increased harvest

c) Decreased harvest

d) Production of longer-lived and lower-emission wood products

e) Conservation of old forests

f) Adaptation (minimizing diseases and damages)

g) Land use change

Scale: 1=Strongly oppose; 5=Strongly support

*Note that in the questionnaire, the strategies were shortly explained before asking this question.

13) Which of the following values affect the most when selecting strategies to mitigate climate change? Please rank the values in order of importance from one (1=most important, 5=least important).

a) Their cost (including possible lost income)

b) Their effectiveness at mitigating climate change

c) Their effects on biodiversity (for example, trees, plants, and animals)

d) Their effectiveness at reducing the risk of diseases and damages (for example, snow, wind, and insect damages)

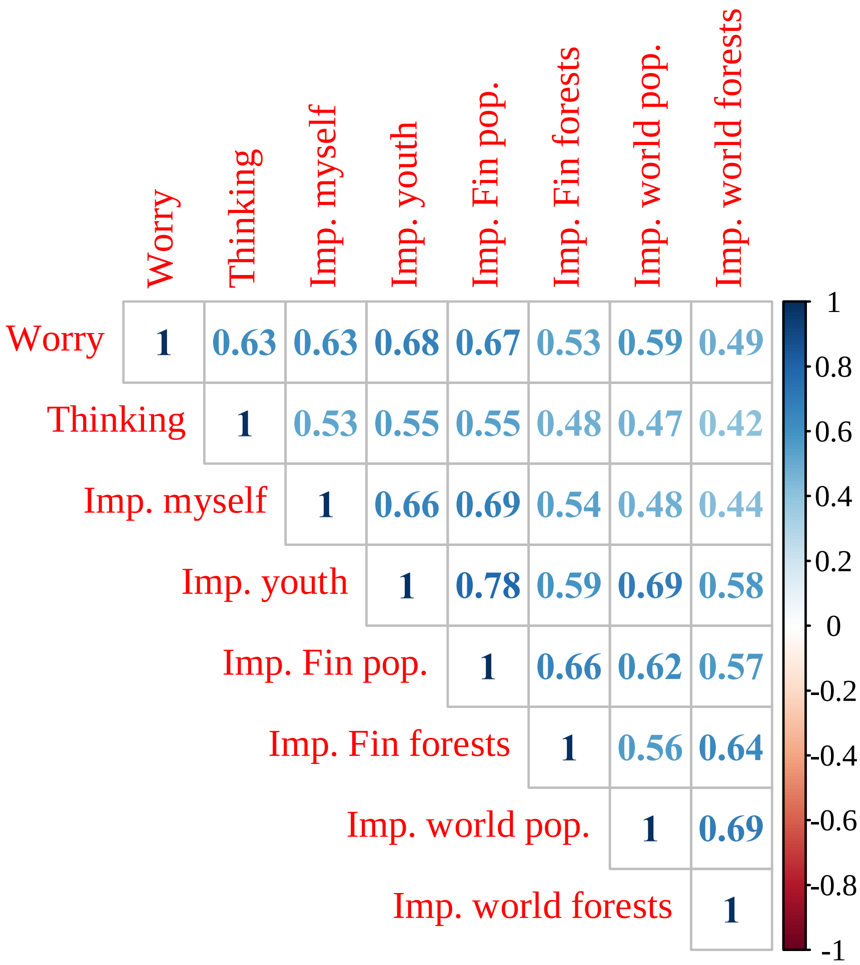
e) Their effects on the local economy (for example, jobs).

Scale: 1=most important, 2= 2nd important, 3=3rd important, 4=4th important, 5=5th (least) important

Appendix 2. The percentage of votes per political party in the 2019 parliamentary elections. Calculated based on the number of votes in the region. Source: Official statistics of Finland, 2019.

		SOCIAL DEMOCRATIC PARTY	FINNS PARTY	NATIONAL COALITION PARTY	CENTRE PARTY	GREENS	LEFT ALLIANCE	SWEDISH PEOPLES' PARTY	CHRISTIAN DEMOCRATS	OTHER
Uusimaa	2019 elections	16 %	14 %	21 %	5 %	18 %	7 %	8 %	2 %	8 %
	Our study	7%	5%	53%	16%	13%	3%	2%	2%	-
North Karelia	2019 elections	21 %	19 %	9 %	24 %	10 %	5 %	0 %	7 %	4 %
	Our study	3%	15%	14%	59%	6%	2%	0%	1%	-
Päijät-Häme	2019 elections	23%	22 %	19 %	10 %	9 %	6 %	0 %	6 %	4 %
	Our study	7%	9%	41%	30%	8%	1%	0%	3%	-

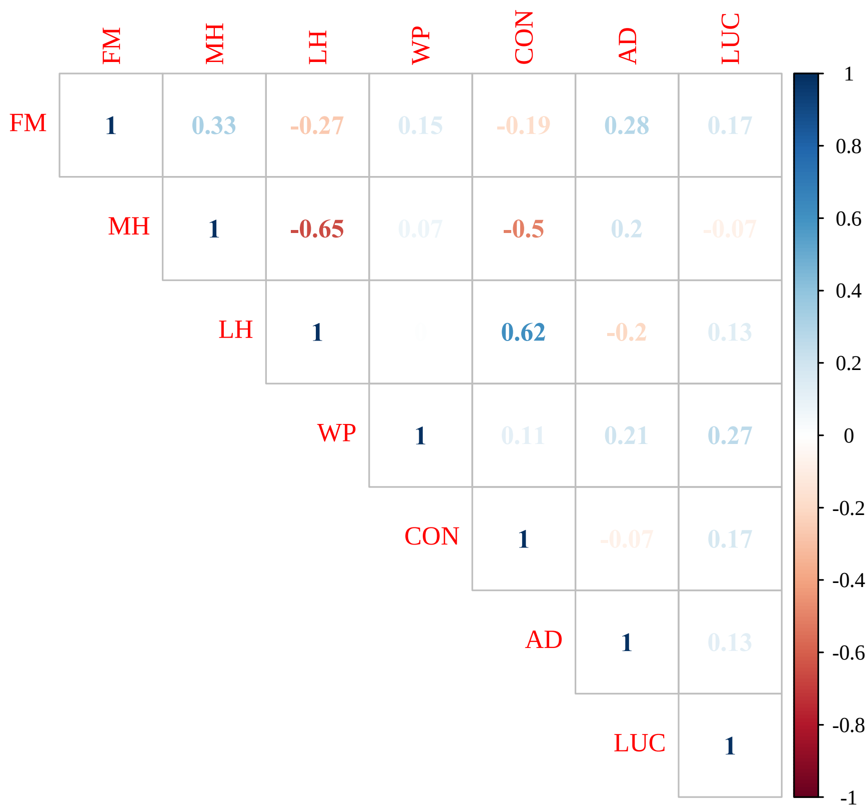
Appendix 3. Correlation matrix for variables measuring worry about climate change, the frequency of thinking about the possible consequences of climate change, and the perceived impacts of climate change.



Appendix 4. Factor loadings of variables measuring worry about climate change, the frequency of thinking about the possible consequences of climate change, and the believed impacts of climate change. Factor analysis was extracted using Varimax rotation.

	Loading
Factor 1 (Perceived risk of climate change, α= 0.92)	
Climate impact youth	**0.86**
Climate impact Finnish population	**0.86**
Climate worry	**0.79**
Climate impact world population	**0.77**
Climate impact myself	**0.74**
Climate impact Finnish forests	**0.74**
Climate impact world forests	**0.71**
Climate thinking	**0.66**

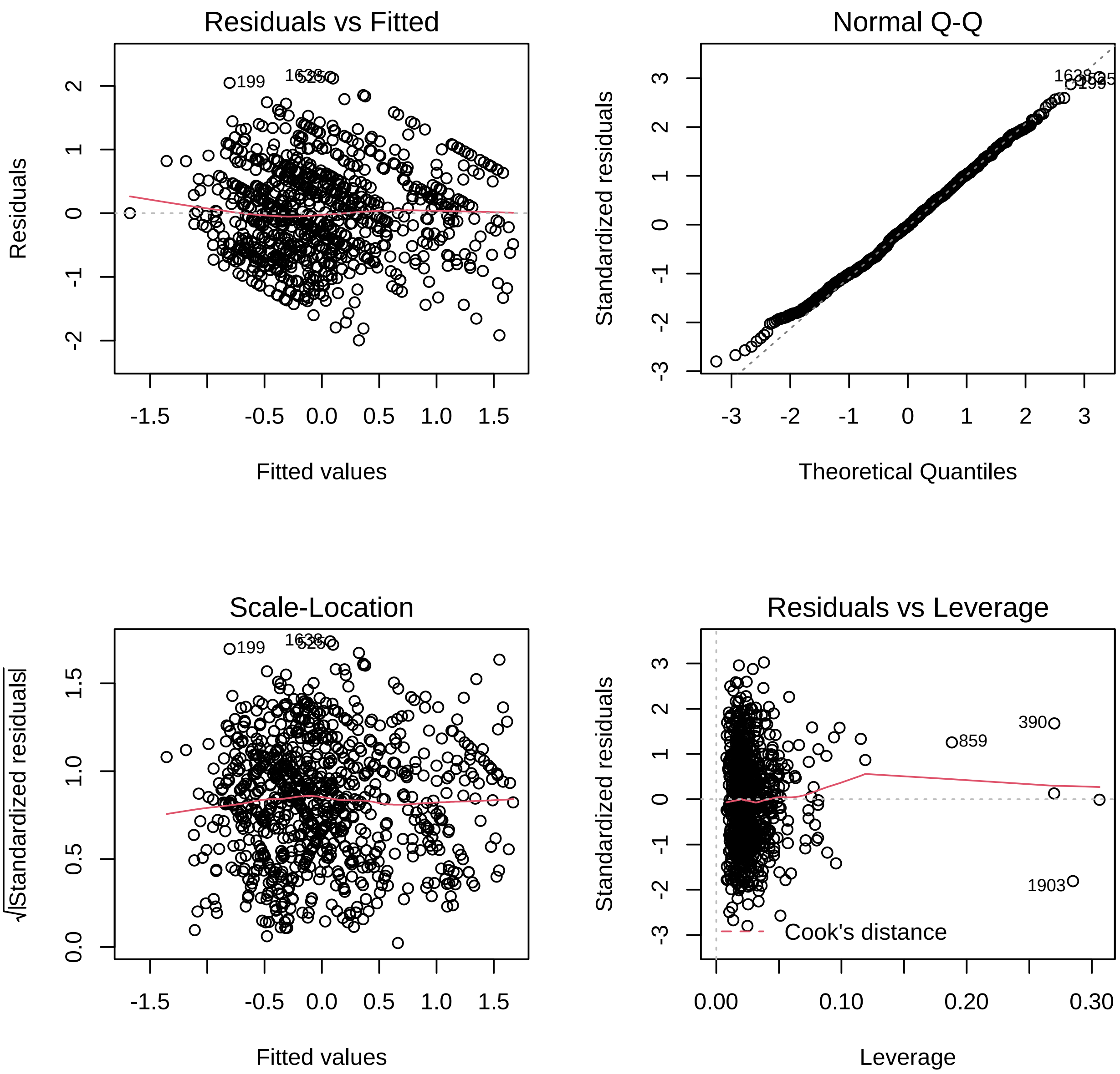
Appendix 5. Correlation matrix for climate change mitigation strategies in the forest sector. FM= Forest management, MH= More harvest, LH= Less harvest, WP= Wood products, CON= Conservation, AD= Adaptation, LUC= Land use change.



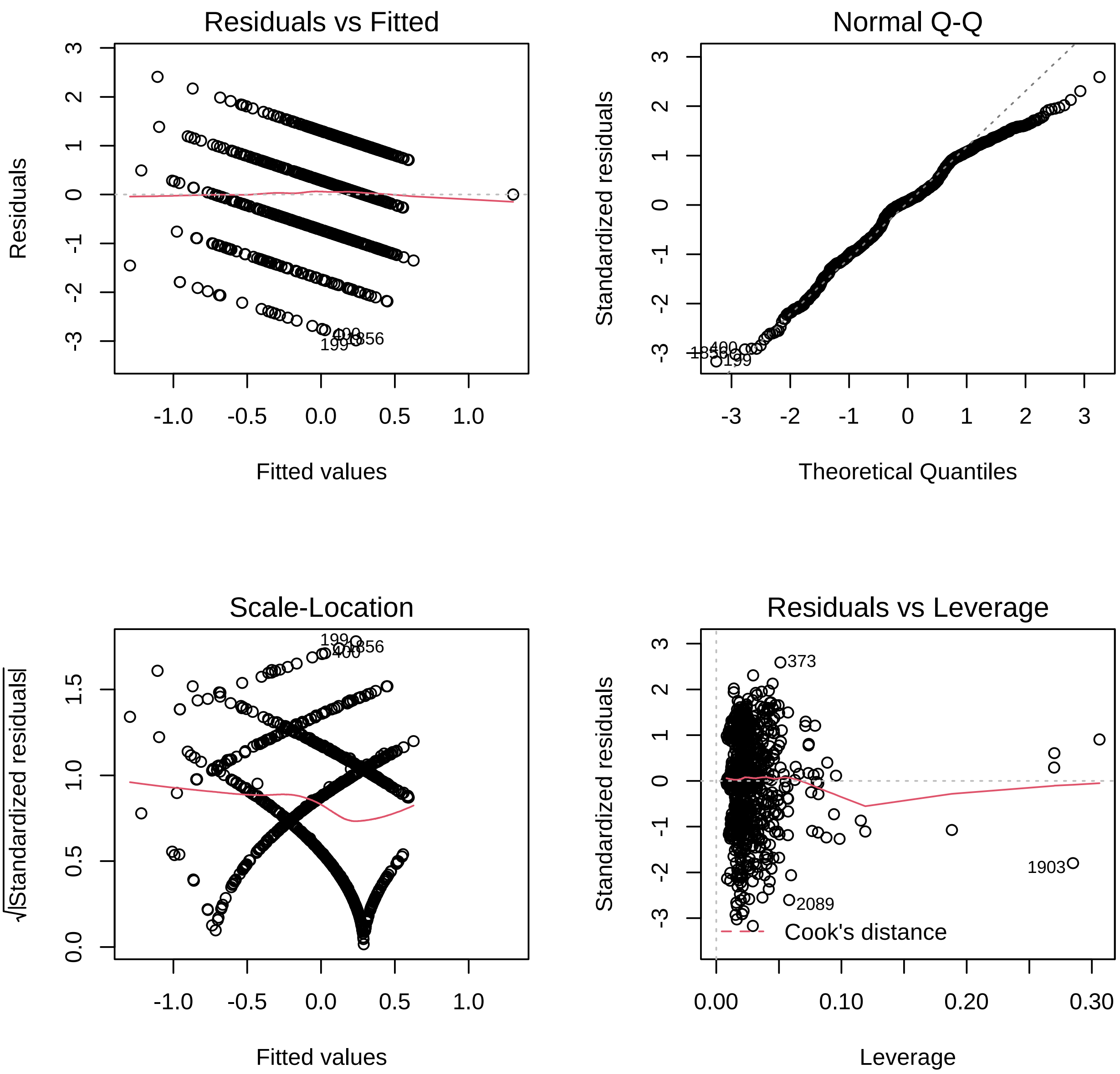
Appendix 6. Generalized variance-inflation factor (VIF) for independent regression variables.

Variable	GVIF	Df	$GVIF^{\frac{1}{2Df}}$
Age	2.21	1	1.49
Gender	1.21	2	1.05
Region	1.52	2	1.11
Occupation	2.71	4	1.13
Education	6.11	1	2.47
Left-right	3.95	1	1.99
GAL-TAN	3.34	1	1.83
Total forest land	1.08	1	1.04
Climate cause	1.71	4	1.07
Perceived risk of CC	1.67	1	1.29
Prioritized value	1.41	4	1.04
Education: Left-right (interaction)	8.90	1	2.98
Education: GAL-TAN (interaction)	3.08	1	1.75

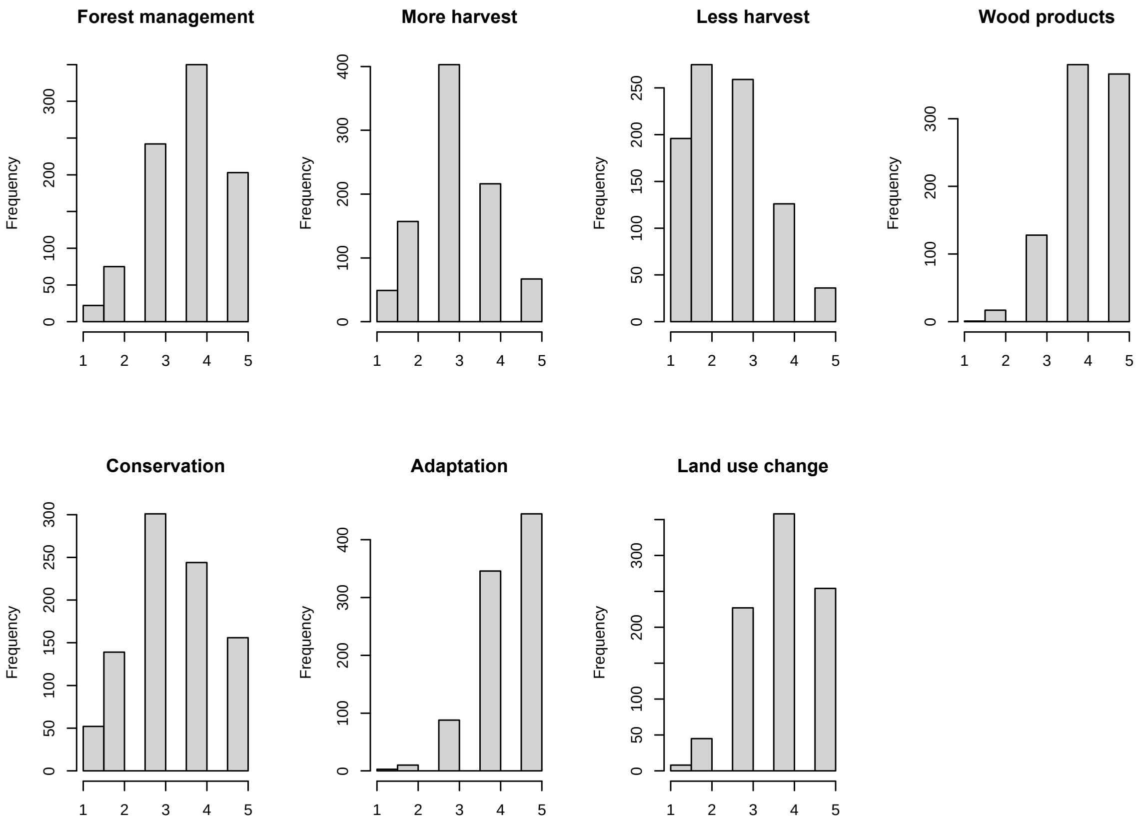
Appendix 7. Regression diagnostics, full Less intervention model.



Appendix 8. Regression diagnostics, full Forest management model.



Appendix 9. Response frequency distributions of all climate change mitigation strategies in the study.



Appendix 10. Descriptive statistics for the strategies.

Descriptive statistics (n=892)	mean	sd	meadian
Forest management	3.71	0.99	4
More harvest	3.11	0.96	3
Less harvest	2.47	1.10	2
Wood products	4.23	0.77	4
Conservation	3.35	1.11	3
Adaptation	4.37	0.73	4
Land use change	3.90	0.90	4

Appendix 11. Base regression models for Less intervention and Forest management.

	Base LessInt Model	**Base ForestMgmt Model**
(Intercept)	**0.58** ***	**-0.36** ***
Age	-0.07	-0.05
Gender - male	**-0.60** ***	**0.37** ***
Gender - prefer not to say	-0.11	-0.55
Region - North Karelia	**-0.34** ***	-0.02
Region - Päijät-Häme	**-0.33** ***	0.02
Occupation - agricultural entrepreneur	**-0.31** *	0.15
Occupation - other entrepreneur	-0.10	0.13
Occupation - other	-0.14	**-0.39** *
Occupation - pensioner	-0.06	-0.02
Education - university	0.08	**0.15** *
R^2	0.15	0.05
Adj. R^2	0.14	0.04
Num. obs.	892	892

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Appendix 12. Full and reduced regression models for Less intervention and Forest management.

	Full LessInt Model	**Reduced LessInt Model**	**Full ForestMgmt Model**	**Reduced ForestMgmt Model**
(Intercept)	**1.08 (0.12)*****	**1.00 (0.11)*****	**-0.86 (0.16)*****	**-0.88 (0.11)*****
Age	-0.02 (0.04)	-0.04 (0.03)	-0.07 (0.05)	**-0.07 (0.03)***
Gender - male	**-0.26 (0.06)*****	**-0.27 (0.06)*****	**0.30 (0.08)*****	**0.30 (0.08)*****
Gender - prefer not to say	-0.08 (0.38)	-0.12 (0.37)	-0.61 (0.50)	-0.80 (0.49)
Region - North Karelia	-0.14 (0.07)	**-0.15 (0.07)***	-0.07 (0.09)	
Region – Päijät-Häme	**-0.19 (0.07)****	**-0.20 (0.07)****	0.03 (0.10)	
Occupation - agricultural entrepreneur	-0.13 (0.12)		0.02 (0.15)	
Occupation - other entrepreneur	0.01 (0.08)		0.11 (0.11)	
Occupation - other	-0.05 (0.13)		**-0.38 (0.17)***	
Occupation - pensioner	-0.07 (0.08)		-0.01 (0.10)	
Education - university	**0.27 (0.12)***	**0.29 (0.12)***	0.12 (0.16)	0.12 (0.07)
H1 Prioritized value - costs	**-0.49 (0.07)*****	**-0.49 (0.07)*****	**0.30 (0.10)****	**0.29 (0.09)****
H1 Prioritized value - local economy	**-0.47 (0.11)*****	**-0.46 (0.11)*****	0.27 (0.15)	**0.29 (0.14)***
H1 Prioritized value - mitigation effectiveness	**-0.23 (0.08)****	**-0.22 (0.08)****	**0.34 (0.10)*****	**0.35 (0.10)*****
H1 Prioritized value - damage effectiveness	**-0.45 (0.08)*****	**-0.44 (0.08)*****	**0.37 (0.11)*****	**0.37 (0.11)*****
H2 Cause - anthropogenic/natural	-0.07 (0.06)		-0.06 (0.08)	-0.06 (0.08)
H2 Cause - natural	-0.22 (0.14)		-0.29 (0.18)	-0.28 (0.18)
H2 Cause - do not know	0.09 (0.20)		0.28 (0.26)	0.31 (0.26)
H2 Cause - not true	-1.18 (0.74)		1.72 (0.98)	1.82 (0.97)
H2 Perceived risk of climate change	**0.18 (0.03)*****	**0.20 (0.03)*****	**0.12 (0.04)****	**0.11 (0.04)****
H3A Political orientation (GAL-TAN) - TAN	-0.07 (0.09)	-0.10 (0.06)	0.10 (0.12)	
H3B Political orientation (left-right) - right	**-0.49 (0.12)*****	**-0.47 (0.11)*****	**0.38 (0.16)***	**0.43 (0.09)*****
H4 University: TAN	-0.01 (0.11)		-0.05 (0.15)	
H4 University: Right	**-0.34 (0.14)***	**-0.35 (0.13)****	0.03 (0.19)	
H5 Total forest land	**-0.07 (0.03)****	**-0.07 (0.02)****	0.01 (0.03)	
R^2	0.41	0.40	0.11	0.10
Adj. R^2	0.39	0.39	0.09	0.09
Num. obs.	892	892	892	892

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Appendix 13. Regression models for individual strategies. FMM= Forest management model, MHM= More harvest model, LHM= Less harvest model, CM= Conservation model, WPM= Wood products model, AM= Adaptation model, LUCM= Land use change model.

	FMM	MHM	LHM	WPM	CM	AM	LUCM
(Intercept)	**-0.86 (0.16)*****	**-0.85 (0.15)*****	**1.08 (0.14)*****	-0.20 (0.16)	**1.07 (0.14)*****	-0.29 (0.16)	0.18 (0.16)
Age	-0.07 (0.05)	-0.07 (0.04)	-0.03 (0.04)	0.02 (0.05)	**-0.08 (0.04)***	**0.17 (0.05)*****	-0.06 (0.05)
Gender - male	**0.30 (0.08)*****	**0.19 (0.07)****	**-0.29 (0.07)*****	**0.20 (0.08)****	**-0.20 (0.07)****	-0.12 (0.08)	-0.05 (0.08)
Gender - prefer not to say	-0.61 (0.50)	-0.01 (0.46)	-0.01 (0.42)	0.34 (0.50)	-0.38 (0.42)	0.21 (0.50)	0.28 (0.49)
Region - North Karelia	-0.07 (0.09)	0.07 (0.09)	-0.13 (0.08)	-0.03 (0.09)	**-0.20 (0.08)***	-0.08 (0.10)	**-0.23 (0.09)***
Region – Päijät-Häme	0.03 (0.10)	0.06 (0.09)	**-0.22 (0.08)****	-0.05 (0.10)	**-0.21 (0.08)****	0.04 (0.10)	-0.13 (0.09)
Occupation - agricultural entrepreneur	0.02 (0.15)	0.03 (0.14)	-0.11 (0.13)	0.03 (0.15)	**-0.32 (0.13)***	-0.06 (0.15)	0.18 (0.15)
Occupation - other entrepreneur	0.11 (0.11)	0.09 (0.10)	0.09 (0.09)	-0.07 (0.11)	-0.13 (0.09)	-0.01 (0.11)	0.08 (0.11)
Occupation - other	**-0.38 (0.17)***	-0.02 (0.16)	-0.01 (0.14)	-0.11 (0.17)	-0.26 (0.14)	-0.19 (0.17)	0.03 (0.17)
Occupation - pensioner	-0.01 (0.10)	0.00 (0.10)	-0.09 (0.09)	-0.19 (0.10)	-0.07 (0.09)	-0.18 (0.10)	-0.08 (0.10)
Education: university	0.12 (0.16)	-0.28 (0.15)	**0.29 (0.14)***	0.38 (0.16)*	0.12 (0.14)	-0.09 (0.16)	0.06 (0.16)
H1 Prioritized value - costs	**0.30 (0.10)****	**0.41 (0.09)*****	**-0.48 (0.08)*****	0.15 (0.10)	**-0.53 (0.08)*****	**0.19 (0.10)***	-0.01 (0.09)
H1 Prioritized value - local economy	0.27 (0.15)	**0.50 (0.14)*****	**-0.42 (0.12)*****	0.15 (0.15)	**-0.49 (0.12)*****	0.08 (0.15)	-0.02 (0.14)
H1 Prioritized value - mitigation effectiveness	**0.34 (0.10)*****	0.18 (0.09)	**-0.23 (0.09)****	-0.01 (0.10)	**-0.27 (0.09)****	0.17 (0.10)	-0.05 (0.10)
H1 Prioritized value - damage effectiveness	**0.37 (0.11)*****	**0.51 (0.10)*****	**-0.40 (0.09)*****	0.04 (0.11)	**-0.46 (0.09)*****	**0.53 (0.11)*****	0.04 (0.11)

H2 Cause - anthropogenic/natural	-0.06 (0.08)	0.06 (0.07)	-0.08 (0.07)	**-0.20 (0.08)***	-0.04 (0.07)	0.08 (0.08)	-0.10 (0.08)
H2 Cause - natural	-0.29 (0.18)	0.04 (0.17)	-0.27 (0.16)	-0.10 (0.19)	-0.20 (0.16)	-0.03 (0.19)	-0.14 (0.18)
H2 Cause - do not know	0.28 (0.26)	-0.03 (0.24)	0.07 (0.22)	-0.07 (0.26)	0.20 (0.22)	0.12 (0.26)	-0.17 (0.25)
H2 Cause - not true	1.72 (0.98)	1.60 (0.91)	-0.93 (0.83)	1.83 (0.99)	-1.26 (0.83)	1.65 (0.99)	**2.25 (0.97)***
H2 Perceived risk of climate change	**0.12 (0.04)****	**-0.09 (0.04)***	**0.17 (0.04)*****	**0.20 (0.04)*****	**0.25 (0.04)*****	**0.12 (0.04)****	**0.26 (0.04)*****
H3A Political orientation: TAN	0.10 (0.12)	0.08 (0.11)	-0.09 (0.10)	-0.08 (0.12)	-0.01 (0.10)	0.00 (0.12)	-0.01 (0.12)
H3B Political orientation: right	**0.38 (0.16)***	**0.41 (0.15)****	**-0.49 (0.14)*****	0.10 (0.16)	**-0.51 (0.14)*****	0.25 (0.16)	-0.10 (0.16)
H4 University: TAN	-0.05 (0.15)	0.14 (0.14)	0.05 (0.13)	0.29 (0.15)	-0.08 (0.13)	0.08 (0.15)	0.03 (0.15)
H4 University: Right	0.03 (0.19)	0.29 (0.18)	**-0.40 (0.16)***	**-0.41 (0.19)***	-0.11 (0.16)	0.15 (0.19)	0.02 (0.19)
H5 Total forest land	0.01 (0.03)	0.03 (0.03)	**-0.08 (0.03)****	-0.01 (0.03)	-0.04 (0.03)	-0.03 (0.03)	**-0.07 (0.03)***
R^2	0.11	0.23	0.36	0.09	0.37	0.09	0.14
Adj. R^2	0.09	0.21	0.34	0.07	0.35	0.06	0.11
Num. obs.	892	892	892	892	892	892	892

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Appendix 14. 0.95 confidence intervals for regression models, Less intervention and Forest management.